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ABSTRACT

The set of 13 units is designed for use with an instructor in actual machine shop practice and is also keyed to audio visual and textual materials. Each unit contains a series of task packages which: specify prerequisites within the series (minimum is Unit 1); provide a narrative rationale for learning; list both general and specific objectives in terms of standards of performance; outline learning activities to be supervised by an instructor; and provide learning practice. Drawings illustrate the text wherever necessary, and occasional reference is given to materials for review or supplementary information. The units are: (1) measuring devices; (2) benchwork; (3) power saws; (4) drill press operations; (5) hand and drill bit grinders; (6) engine lathe (in two parts); (7) horizontal milling machine operations; (8) vertical milling machine operations; (9) surface grinder operations; (10) shaper operations; (11) sheet metal; (12) oxy-acetylene welding; and (13) arc welding. (MDW)

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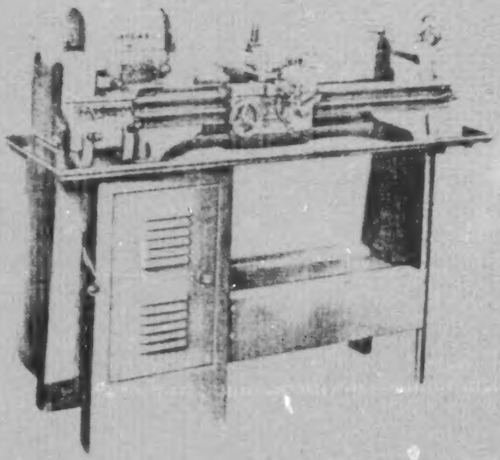
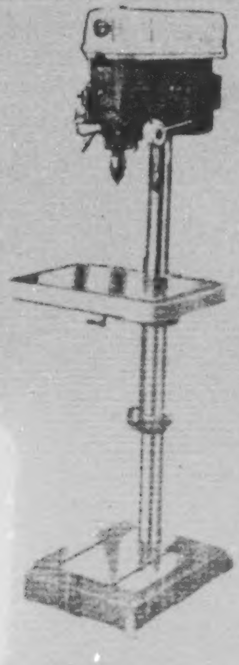
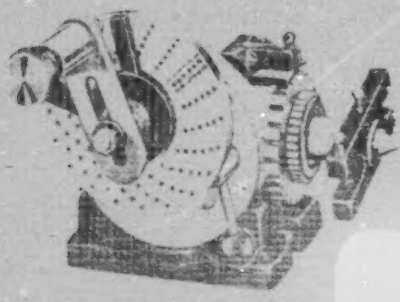






CLUSTER: METALS

COURSE: MACHINE SHOP

CE003731 (a)

UNIT PACKAGE I: MEASURING DEVICES

PREREQUISITES: NONE

RATIONALE:

You have, for one reason or another, chosen to enter the field of machine shop work. Welcome to a fascinating world that combines the skills of the old-time craftsman with the modern technology of today's computer world. Your choice, if you decide to pursue this trade, will lead you down many avenues of adventure where you will explore and use machines and equipment that will be yours to command. The end product produced by these machines, will reflect the keenness of your mind and the skill of your hands. Does this seem that it might be an overwhelming undertaking for you to accomplish? If it does, don't be overly concerned about it, because you will be started at the beginning and will proceed at your own pace. It will take hard work on your part and you must be willing to do some solid thinking, but in a very short time you will find yourself developing skills that will be leading you to the position of a craftsman in the trade.

In this first unit you will be introduced to some tools that will help you form a habit that will remain with you for your lifetime. This habit is the one of accuracy! Remember that word; keep it in your mind at all times. Don't take short cuts at the expense

RATIONALE (cont'd):

of accuracy. The measuring devices that you will be using in this unit are all tools of accuracy; learn to use them as such and you will be on your way to becoming a craftsman.

A craftsman is always his own man!

OBJECTIVES:

General:

Upon completion of this unit, you will be able to recognize some of the various measuring devices used by the machinist and will have used these devices to make semi-precision and precision measurements.

Specific:

Upon completion of the task packages for this unit, you will be able to use:

1. A machinist's scale to measure the length and width of a piece of flat stock. Your acceptable performance will be determined by an accuracy of ± 1/32nd of an inch.

2. A caliper rule to measure the outside and inside diameters of tubing. A tolerance of ± 1/32nd of an inch will be the acceptable standard of performance.

3. A scale and dividers to transfer to a workpiece the height and width measurements from a drawing provided by your instructor. The standard of acceptable performance is a tolerance of 1/32nd of an inch.

OBJECTIVES (cont'd):

4. The combination square set for scribing angles and straight lines on workpieces and finding the center of round stock. Performance requirements involve an accuracy of ± 1/32nd of an inch.

5. Hermaphrodite calipers to scribe parallel lines, transfer measurements, and find the center of round stock. A standard of accuracy of ± 1/32nd of an inch will be required.

6. A combination square head and blade, surface gage, and surface plate to measure and scribe lines on a vertical surface. A tolerance of ± 1/32nd of an inch will be the acceptable standard of performance.

7. An outside micrometer caliper to measure the diameter of a rod, the thickness of sheet metal, and the length of stock within the capacity of the instrument. A standard of accuracy of ± .001 of an inch will be required.

8. Inside and outside spring calipers and micrometers to measure tubing diameters. A standard of accuracy of ± .001 of an inch will be required.

9. Telescoping gages and micrometers to measure inside diameters. A standard of accuracy of ± .001 of an inch will be required.

10. A depth micrometer to measure the depth of open and blind holes, grooves, and slots. A standard of accuracy of ± .001 of an inch will be required.

OBJECTIVES (cont'd):

11. Vernier gages to measure heights, lengths, widths, and inside and outside diameters of stock. A standard of accuracy of .001 of an inch will be required.

12. Precision gage blocks and a surface plate to check the accuracy of a dial indicator. The acceptable standard of performance will be an accuracy of ± .0005 of an inch.

13. A dial indicator, gage blocks, and surface plate to test the concentricity (roundness) of stock. A standard of ± .001 of an inch will be required.

LEARNING ACTIVITY:

The task packages in this unit have been designed to be worked in sequence. Starting with the first package on the machinist's scale, these packages will gradually lead you from semi-precision measurements to precision measurements. In this manner you will gain an ability to use measuring tools that range from the simple to the complex. By doing each task package completely and carefully, you will prepare yourself for the next task package.

While doing the task package you will be directed, at certain points, to show your work to your instructor. This is a good time to ask him any questions you may have, not only about the task package, but also about any phase of the machine shop that may interest you. Your instructor has had a lot of experience in machine work and he will be glad to answer your questions.

LEARNING ACTIVITY (cont'd):

In the task packages you will be asked to view a sound-slide presentation, read and answer questions, and perform some practical exercises. The number and names of the task packages included in this unit are as follows:

TASK PACKAGE 1: MACHINIST'S SCALE
TASK PACKAGE 1A: METRIC SCALE
TASK PACKAGE 2: SLIDE CALIPER
TASK PACKAGE 3: DIVIDERS
TASK PACKAGE 4: COMBINATION SQUARE SET
TASK PACKAGE 5: HERMAPHRODITE CALIPERS
TASK PACKAGE 6: SURFACE GAGE
TASK PACKAGE 7: MICROMETER CALIPER
TASK PACKAGE 7A: METRIC MICROMETER
TASK PACKAGE 8: SPRING CALIPERS
TASK PACKAGE 9: TELESCOPING GAGES
TASK PACKAGE 10: DEPTH MICROMETER
TASK PACKAGE 11: VERNIER GAGES
TASK PACKAGE 11B: METRIC VERNIER
TASK PACKAGE 12: DIAL INDICATOR AND GAGE BLOCKS
TASK PACKAGE 13: DIAL INDICATOR

At this point, if you feel qualified to pass a comprehensive test covering this unit, you should contact the instructor for the unit post-test. If, however, you do not feel qualified to take the test, proceed to the first task package in this unit.

M-I-1

UNIT I: MEASURING DEVICES

TASK PACKAGE #1: MACHINIST'S SCALE

RATIONALE:

In this task package you will take the first step in a journey that can lead you to a rewarding career, as a craftsman, in the machine industry. This first step will introduce you to some of the instructional materials you are going to use and also to a tool, the machinist's scale, that will become a constant companion in the weeks ahead.

Successful work in a machine shop requires a great degree of accuracy. While the machinist's scale is not thought of as a highly accurate tool, it is, nevertheless, used many times during the day to make rough measurements of stock and for laying out workpieces for machining. Developing a skill in using the machinist's scale, and it does take skill, will save you time, reduce waste, and improve your craftsmanship. Good craftsmanship means better job opportunities.

Through the Learning Activities and Learning Practices in this task package, besides being introduced to the materials and machinist's scale, you will also begin to use the scale and acquire a few "tricks of the trade" in using it better. Take your time and learn about this important tool and, who knows, you may

RATIONALE (cont'd):

find it can be fun to learn. Other people have, you know!

OBJECTIVE:

Upon completion of this task package you will be able to use a machinist's scale to measure the length and width of a piece of flat stock. Acceptable performance will be determined by an accuracy of ± 1/32nd of an inch.

LEARNING ACTIVITIES:

1. In Machine Shop Operations and Set-ups, read pages 9 through 12, up to the section on the Slide Caliper Rule.
2. Read page 51, the section entitled Ruler, in Machine Tool Technology, and look at the pictures in the remainder of the unit. Here you will see some of the other measuring devices used in machine shop work and later you will be using some of them.
3. View Sound-Slide Package #M-I-1

   NOTE: Having trouble with fractions? Better study Mathematics for Vocations, Packages #1 and #2.
4. Look at the first drawing in this task package, Figure 1. It shows a scale graduated in 1/8 and 1/16 increments.

LEARNING ACTIVITIES (cont'd):

a. On the 1/8 side of the scale make a mark and label each of the following points:

(a.) 1/16	(d.) 2 1/16
(b.) 7/16	(e.) 2 13/16
(c.) 1 9/16	(f.) 5 15/16

NOTE: To obtain these measurements you must divide the 1/8 increment in half.

b. On the 1/16 side of the scale do the same thing at the following points:

(a.) 1/32	(d.) 2 1/32
(b.) 7/32	(e.) 2 13/32
(c.) 1 9/32	(f.) 5 15/32

NOTE: There is a difference between 7/16 and 7/32. Do you see it?

5. Figures 2 and 3 of this task package show some of the ways in which a machinist's scale is used. Can you read the measurements correctly? Write them down in the blanks.

Figure 2 is ____________________

Figure 3 is ____________________

6. Show the work you have done to your instructor and see if your answers are correct.

LEARNING PRACTICE:

Tools and Equipment

1. Machinist's scale
2. Tape
3. Writing paper
4. Pencil or pen

1. Secure three pieces of stock of different sizes. Tape a small piece of paper, with your name on it, on each piece of stock.
2. Measure the length of the stock to the nearest 1/32nd of an inch and record on the paper.
3. Measure the width of the stock to the nearest 1/32nd of an inch and record on the paper.
4. Have your instructor check your measurements.

NOTE: Once you have mastered reading the machinist's scale, you can easily read other scales even if they are divided into smaller parts. You might try reading the 1/64 of an inch scale just to see how easy it is. You will also notice that many people who work in the machine shop carry a small 6" scale in their pockets. It's a handy tool to have and you may want to get one.

Remember the scale is a tool for measuring; it is not a screwdriver, or a drumstick, or a paddle. Use it wisely and it will help you increase your wisdom. You should now be ready to do your next task package. Pat yourself on the back a couple of times and then get started on Package 2.

LEARNING PRACTICE:

Tools and Equipment

1. Caliper rule
2. Writing paper
3. Tape
4. Pencil or pen

1. Obtain from your instructor three different sizes (in diameter) of tubing.
2. Measure the inside and outside diameters of each piece of tubing to the nearest 1/32nd of an inch, and write down these measurements and your name on a piece of paper.
3. Tape the paper to the tubing; make sure you have the right measurements for the piece of tubing.

Don't let different measuring devices confuse you. The divisions this far are the same, so if you can read the machinist's scale you can read the caliper rule.

You have now completed the second step in the "package generation." See your instructor for the next step and have him check the work you have done.

STEEL SCALE GRADUATIONS

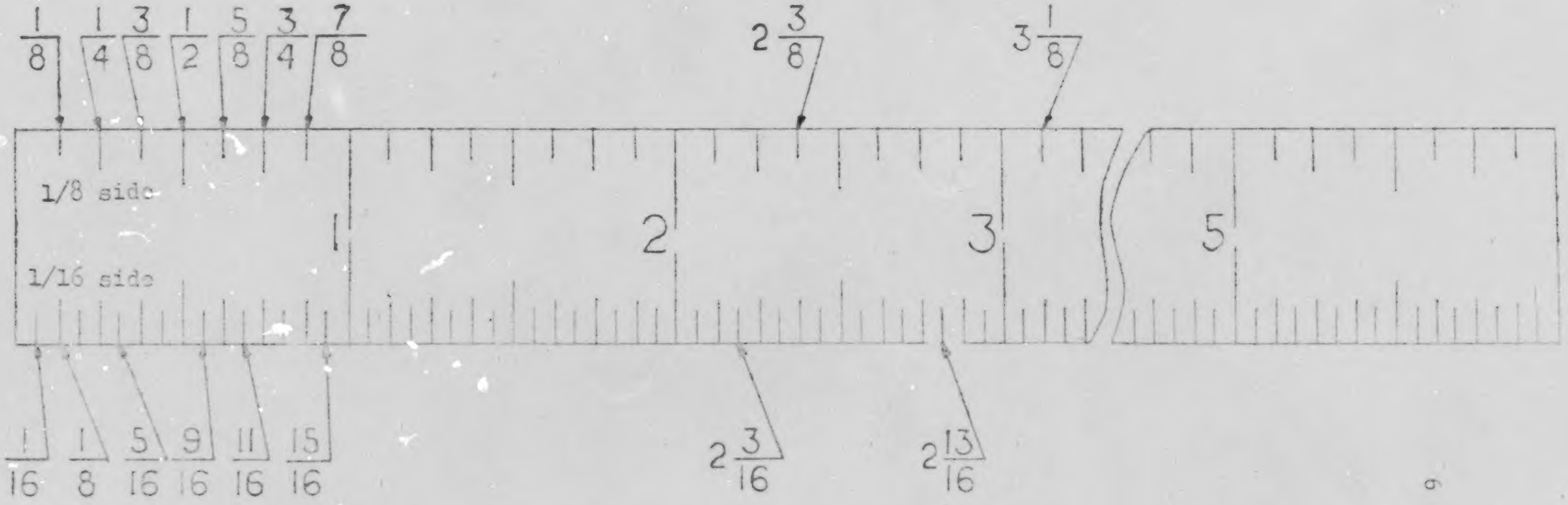
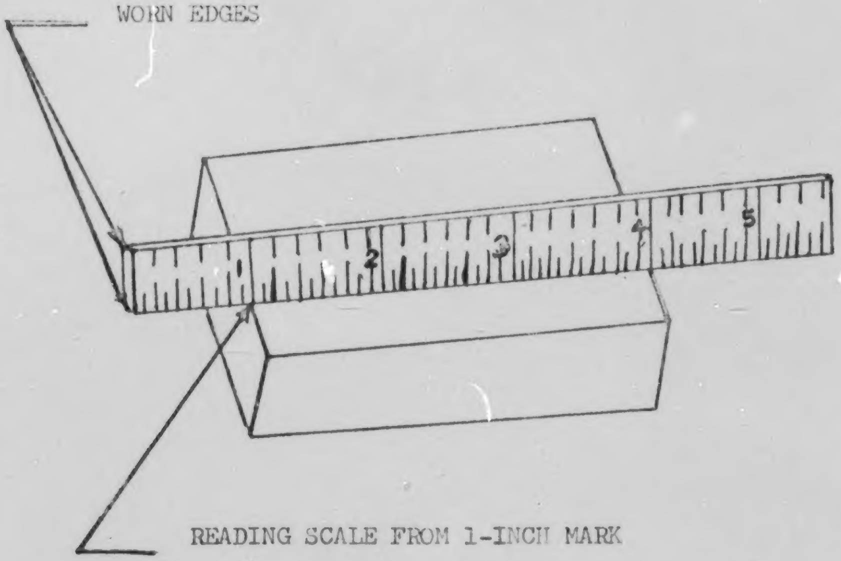
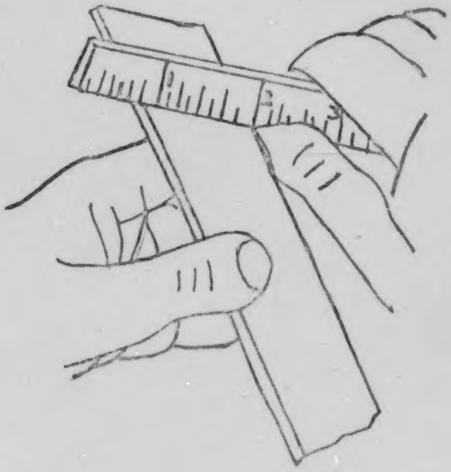


Figure 1



METHOD OF USING THE 1 INCH MARK OF A STEEL SCALE FOR MEASUREMENTS
FIGURE 2



METHOD OF MEASURING FLAT PARTS UNSING A STEEL SCALE
FIGURE 3

UNIT I: MEASURING DEVICES

TASK PACKAGE #2: SLIDE CALIPER

PREREQUISITES: TASK PACKAGE 1, UNIT 1

RATIONALE:

You have learned to use a machinist's scale in the first task package and with it measured the length and width of pieces of stock. There are other measurements that can be made with the machinist's scale and, as you have seen from looking at the pictures in the reference material, there are other types of measuring devices. In this task package you will learn to use another one of these devices, the caliper rule, and increase your ability to do accurate work.

The caliper rule is useful for measuring inside and outside diameters of tubing or pipe, and it can also be used for making other measurements. How useful this measuring tool or any measuring tool is depends a great deal on you and on how willing you are to try different ways of using these tools and on how much effort you put into learning about them. The task package gives you the basic idea on the use of the tool, but the rest is up to you. So go get'em, Tiger!

OBJECTIVE:

Upon completion of this task package you will be able to use a caliper rule to measure the outside and inside diameters of tubing. A tolerance of ± 1/32nd of an inch will be the acceptable standard of performance.

LEARNING ACTIVITY:

1. The reading assignments on the caliper rule are rather short, but this should not bother you too much since you can read a machinist's scale. On page 51 in Machine Tool Technology there are two paragraphs to read under the section Caliper Rule and Figure 3-5 shows a picture of one type of rule. Notice the words OUT and IN and the lines close to these words:
   a. What is the OUT line used for? _____ _____ ______
   b. What is the IN line used for? ______ ______ _____
2. Now take a look at page 13, Figure 6, in Machine Shop Operations and Set-ups and see one way in which the slide caliper rule (either name is correct for this measuring tool) is used. Notice in figure 6, by the right hand thumb, a black wheel. This is a locking device that is used when you make your measurement. There are times when you are making a measurement that you can not read the scale so you lock the slide caliper on the piece,

LEARNING ACTIVITY (cont'd):

take it off the piece, and then read the measurement. This is a handy feature that can save you time and trouble when you use the caliper rule. Don't forget to read the material on pages 12 and 13 under the section on the Slide Caliper Rule! Also answer these questions:

a. What are the two proper names of this measuring device?

1. ____________________ 2. ____________________

b. What allows you to remove it from the piece without changing the measurement? ________________________

3. View the slide-sound program # M-I-2.

This shows another type of caliper rule and it's one that you have in your machine shop so you will be using it. There are some differences between this caliper rule and the ones in your reference books, but these differences are not enough to bother you. Figure 1 in this package also shows a caliper rule that is very similar to the one in the slide-sound program. Notice that it does not have a marking for the OUTSIDE measurement. Instead the lower jaw is used for the lineup point or line. Two other differences you have likely noticed already, are the lack of a locking device and the wood construction of the caliper rule in

LEARNING ACTIVITY (cont'd):

the slide-sound program.

I think by this time you can see the usefulness of the caliper rule so go on to the learning practice, after your instructor has checked your work.

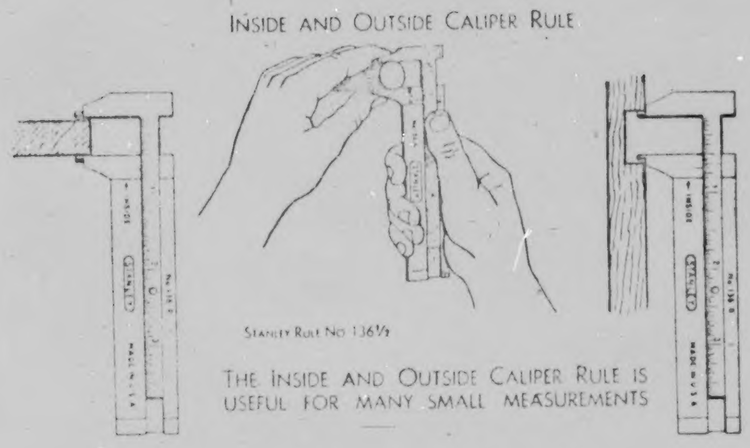

INSIDE AND OUTSIDE CALIPER RULE
STANLEY RULE NO 136½
THE INSIDE AND OUTSIDE CALIPER RULE IS USEFUL FOR MANY SMALL MEASUREMENTS

Figure 1

LEARNING PRACTICE:

SHOP WORK

1. Obtain from your instructor three different sizes (in diameter) of tubing.
2. Measure the inside and outside diameters of each piece of tubing to the nearest 1/32nd of an inch, and write down these measurements and your name on a piece of paper.
3. Tape the paper to the tubing; make sure you have the right measurements for the piece of tubing.

TOOLS AND EQUIPMENT

1. Caliper Rule
2. Writing Paper
3. Tape
4. Pencil or pen

Don't let different measuring devices confuse you. The divisions this far are the same, so if you can read the machinist's scale you can read the caliper rule.

You have now completed the second step in the "package generation". See your instructor for the next step and have him check the work you have done.

M-I-3

UNIT I: MEASURING DEVICES

TASK PACKAGE #3: DIVIDERS

PREREQUISITES: UNIT I, TASK PACKAGE 2

RATIONALE:

Are you ready for another measuring device? This one is a little different from the last two because it has no scales to read, but it still is an important tool and one that will help you to your goal of becoming a craftsman. It's called a divider and has many uses as you will soon see.

One of the important uses of the divider is transferring measurements from a drawing to the piece you are working on. Because of the methods used to reproduce drawings, you cannot use your machinist's scale or divider directly on the drawing; instead, you must read the dimensions on the drawing, set your divider to that measurement, using a scale, and then transfer the measurement to the work piece. This sounds like a lot of work, but I think by the time you have finished this package you will have developed enough skill to do it without too much trouble and will find it really isn't a lot of work. Also, it's worth it for the increase in accuracy you will gain. Remember, accuracy is the name of the game in the machinist's trade.

OBJECTIVE:

Upon completion of this task package you will be able to use a scale and dividers to transfer to a workpiece the height and width measurements from a drawing provided by the instructor. The standard of acceptable performance is a tolerance of 1/32nd of an inch.

LEARNING ACTIVITY:

1. While most of your reference material has information about the use of dividers, the book Metal Work Technology and Practice has the most complete coverage of this topic. Page 52, section 65, gives some basic information about the dividers, and a picture of this tool is in the lower left-hand corner of figure 42. Take a look at the picture, read the information, and answer these questions.

   a. How is the size of the divider measured? ____________________

   ____

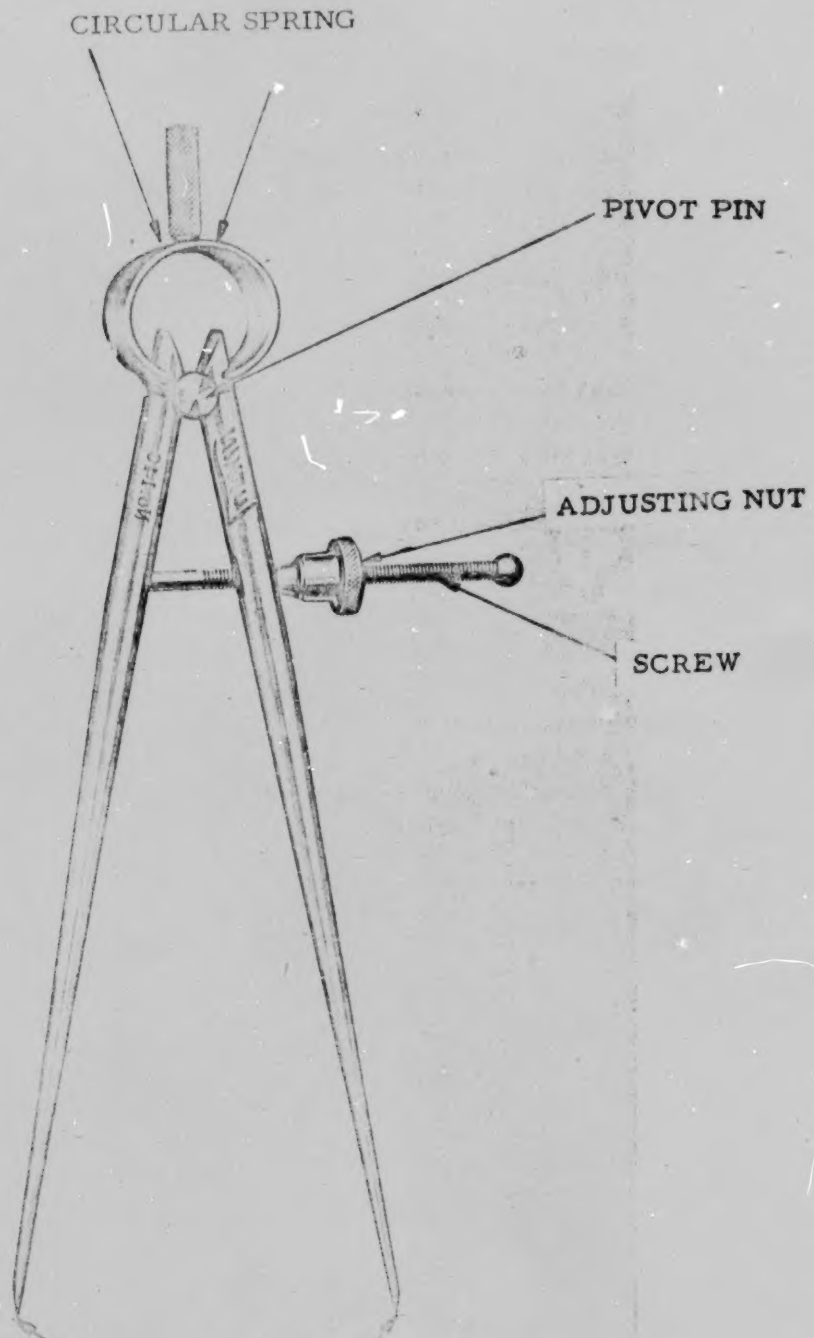
   ____

   b. How do you sharpen the divider? ____________________

   ____

   ____

MEET THE DIVIDER!



LEARNING ACTIVITY (cont'd):

2. On pages 65 and 66 in the same reference source you will see several uses of the divider. Of particular importance to you is figure 82 on page 65.

   a. What does figure 82 show? ______________________________

   b. What does figure 83 show? ______________________________

   c. What is the radius of a circle? ___________________________

   d. What do you need besides the divider to measure distance?

      ____

   e. If you are "stepping off along a neutral line," what are you measuring? ______________________________

      ____

   f. Find two other uses for the dividers in Unit 8 on page 68 and list them (hint: don't go past page 69).

      1.

      2.

3. For some more information on the divider view slide-sound program #M-T-3.

4. You have now seen many ways in which the divider is used. As you work in the machine shop you will discover more uses for this tool and, in fact, may even invent some new uses. There is one thing to remember about the divider. It is a tool - a SHARP tool! Handle it with care. It is not a toy!

LEARNING ACTIVITY (cont'd):

Respect it!

5. One more reading assignment and you will be ready to do some work with the divider. Read and study carefully the illustrations in Units 1 and 2 in Blueprint Reading for Machinists. You will need this information to help you read drawings.

You know this has been a long activity, but you are now ready to charge into your learning practice. As soon as you have your answers checked by your instructor, that is!

LEARNING PRACTICE:

Tools & Equipment

1. 12" machinist's scale
2. 6" dividers
3. Plain paper
4. Pencil or pen

1. From your instructor, obtain a sheet of plain paper 8 1/2" wide by 11" long and do the following:
   a. Draw vertical lines on the left and right sides of the paper, one inch in from the edge and from the top to the bottom.
   b. Draw a horizontal line 2" down from the top edge of the paper and from the left vertical line to the right vertical line [illegible] three more lines 1" apart under the top line. (You now have two vertical and four horizontal lines).

LEARNING PRACTICE (cont'd):

c. Set your dividers at 1" and make points down along each vertical line to the bottom of the page. (Don't worry if you make small holes in your paper).

d. Connect these points with horizontal lines. (Your paper should now have 2 vertical lines and 9 horizontal lines. Does it?)

You have now used dividers to transfer measurements!!

2. Try some more of this new skill by transferring some additional measurements.

a. Number your horizontal lines.

b. Transfer the following measurements to the numbered lines and label the point on the line.

(1) 7/16
(2) 9/32
(3) 5/8
(4) 1 5/32
(5) 1 15/16
(6) 2 3/4
(7) 4
(8) 5 1/4
(9) 6 3/32

Have your instructor check this page and if you did a good job, go on to the final learning practice.

3. Now transfer some measurements from a drawing on page 8, Blueprint Reading for Machinists, to a piece of stock. Use the length measurement from the front view and the width measurement from the top view.

NOTE: Never measure directly from a drawing. Always use

LEARNING PRACTICE (cont'd):

the dimensions given, set your divider with a scale, and transfer the measurements with your divider to the piece of stock.

When your instructor has checked your work and it has been done correctly, "take a bow, because you really earned it." Now go on to the next task package.

UNIT I: MEASURING

TASK PACKAGE #4: THE COMBINATION SQUARE SET

PREREQUISITES: UNIT I, TASK PACKAGE 3

RATIONALE:

You know how to measure lines and objects and transfer measurements from a drawing to a workpiece; now you are going to learn how to draw lines and angles on a piece of metal and mark the center of a piece of round stock. All this will be done with a set of tools called the "combination square set." There are many other ways in which this somewhat remarkable tool can be used, and as you increase your craftsmanship you will find this out for yourself. You will also find that the combination square set is no stranger to the tool box of automobile mechanics, aircraft metalsmiths, carpenters, and just about every known trade.

Learning about the combination square set puts you in good company!

OBJECTIVE:

Upon completion of this task package you will be able to use the combination square set for scribing angles and straight lines on workpieces and finding the center of round stock. Performance requirements involve an accuracy of ± 1/32nd of an inch.

LEARNING ACTIVITY:

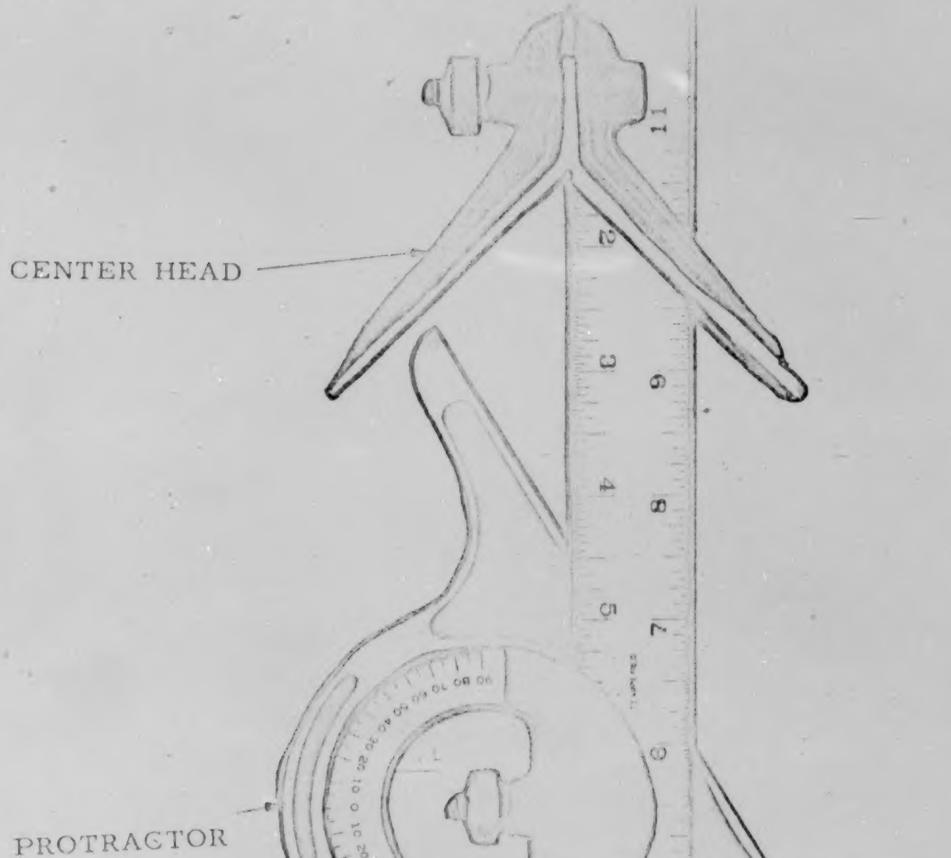
1. Before you advance into these learning activities too far, take a look at the picture on the bottom of page 49 in Metalwork Technology and Practice. The man in the picture is using a part of the combination square set in a very professional manner. Someday you will be doing this type of work.

2. Start your reading about the combination set in the same book on page 55, Sections 81, 82, 83, and 84. There are four main parts to the combination set; can you name them:

a. ____________ b. ____________ c. ____________

d. ____________. Did you include the spirit level as one of the parts? While it is an important part you should not think of it as a main part. Also notice that there is a small scriber in the square head. It's a useful tool if

I'M NICE TO KNOW



COMBINATION SQUARE SET

LEARNING ACTIVITY (cont'd):

someone doesn't lose it. Always be careful with your tools.

3. Page 56 in Metalwork Technology and Practice, figure 57, shows some of the uses of the combination square. Look through the remainder of this unit (6), and the next two units and see if you can find three more uses for the combination square:

	Page No.	Figure No.	Uses
a.			
b.			
c.			

NOTE: You may measure or scribe any angle with the bevel protractor head.

5. Now try the same thing for the center head and in the same three units (6, 7, & 8). Hint! One use is not finding a center.

	Page No.	Figure No.	Uses
a.			
b.			

NOTE: Can you see how you could use the center head to find a center for a bridged hole? See figure 97, page 68.

6. To change the subject just a bit, read section 62 on page 51. This tells about the scriber.

LEARNING ACTIVITY (cont'd):

7. Don't forget other reference material has information about this tool. See slide-sound program #M-I-4.
8. Let your instructor check your work and see if it's O.K.

LEARNING PRACTICE:

Tools & Equipment

1. Combination Square Set.
    a. Rule or blade.
    b. Square head.
    c. Center head.
    d. Bevel protractor.
2. Scriber.
3. Layout fluid and brush.

1. Obtain from your instructor a piece of stock with at least one straight edge and large enough to draw a 4" by 6" rectangle on it. Also three pieces of round stock (different diameters are needed). When you have this material and the tools and equipment listed, you are ready to get to work.

   NOTE: If your metal is such that you can't see your scribed lines, try using the layout fluid to color the metal. See pages 62 and 63, Sections 99 & 100, in Metalwork Technology and Practice.
2. Using the straight side as a guide and also as one of the sides, construct a 4" x 6" rectangle, using the combination square head.

LEARNING PRACTICE (cont'd):

a. On the straight edge, at the halfway point (either 2" or 3" depending on the length of the side) scribe a point.

b. With your square head at the half-way point you just made, scribe one line 90° from the edge and two lines 45° from this 90° line.

c. Using the bevel protractor head and blade and the same halfway point, scribe lines at 35°, 25°, and 20° on each side of the 90° line.

3. Using the center head and the three pieces of round stock, mark the center of one end on each piece. If you have trouble doing this your instructor may want you to do the other ends.

Now show your work to your instructor and see if you are ready to go on to your next package. By the way, how many of your friends can do this ?

UNIT I: MEASURING DEVICES

TASK PACKAGE #5: HERMAPHRODITE CALIPER

PREREQUISITES: UNIT I, TASK PACKAGE 4

RATIONALE:

Still learning about measuring devices! Does it seem to you like there is an endless number of tools used for doing something about measuring? You are right! There is an endless number, and more are being invented all the time. The one that you will learn about in this task package contains parts of two tools. One of these tools, the divider, you already know about, and the other one, the inside caliper, you will get to know in a later task package. The parts of these two tools joined together form a tool called the hermaphrodite caliper. That's some name for a tool. If you look the word up in the dictionary one of its meanings is "a combination of diverse elements," and that is what the hermaphrodite caliper is.

Is the hermaphrodite caliper a useful tool? You will have the answer to this question when you finish this package. So hurry and get started!

OBJECTIVE:

Upon completion of this task package you will be able to use hermaphrodite calipers to scribe parallel lines, transfer measurements, and find the center of round stock. A standard of accuracy of ± 1/32nd of an inch will be required.

LEARNING ACTIVITY:

1. One type of hermaphrodite caliper is shown on page 60, figure 7-16, of Technical Metals. Look at this picture and also read the two short paragraphs concerning this tool. Now look at figure 7-17 on the same page and see this caliper in use.

   a. What is the machinist doing? ______________________

   ____

2. Machine Tool Technology on page 54 has about the same picture and also the paragraphs about the caliper are almost the same as the previous one so you don't have to study it in detail. Instead turn to page 69 and read through the section "Procedure for Locating Centers with the Hermaphrodite Caliper."

LEARNING ACTIVITY (cont'd):

a. Figure 3-77, page 70 of Machine Tool Technology shows the ends of three pieces of round stock. In the space below, write in how the caliper was set for each piece of stock.

(1) Piece A

(2) Piece B

(3) Piece C

3. View the sound-slide program M-I-5.

4. Have your instructor check your work, and if all is well, go on to the Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Hermaphrodite caliper
2. Layout fluid and brush
3. Machinist's scale
4. Scriber

1. Obtain, from your instructor, a piece of flatstock that has at least one good straight edge.

a. Scribe a line parallel to, and 9/32nds of an inch from, the straight edge.

LEARNING PRACTICE (cont'd):

b. Add three more parallel lines, each 9/32nd of an inch apart.

NOTE: Having trouble with adding or multiplying fractions?

See Mathematics for Vocations, packages 2 and 3.

2. Now find the center of the end of a piece of roundstock. Ask your instructor for this stock and when you have completed this practice show him all of your work. If it is correct, see if it is time for you to try the next package. By the way, have you been cleaning your tools and putting them away at the end of each task package? Don't forget; you can usually tell a good craftsman by the condition of his tools.

UNIT I: MEASURING DEVICES

TASK PACKAGE 6: SURFACE GAGE

PREREQUISITES: UNIT I, TASK PACKAGE 5

RATIONALE:

One of the many problems you may encounter, working in the machine shop, is scribing lines on a vertical surface. There are several ways to overcome this problem and you will learn one in this task package. The tools used for doing this job are much more accurate than the ones you have used up to now. They are also tools you will use many times when you are doing layout work.

The main tool in this task package is the surface gage. It doesn't look like much of a tool, but as you use it you will come to respect if for the many jobs it can do. Like all measuring tools, the surface gage is not a toy to be played with. Mistreat it, and it soon will be nothing but a piece of junk. Treat it well and the skills you will learn in using it will become valuable assets in the years to come. These assets can pay off in a short time.

OBJECTIVE:

Upon completion of this task package you will be able to use a combination square head and blade, surface gage, and surface plate to measure and scribe lines on a vertical surface. A tolerance of ± 1/32nd of an inch will be the acceptable standard of performance.

LEARNING ACTIVITY:

1. View slide-sound program #M-I-6.
2. The surface gage is normally used with a surface plate. The surface plate is a rather simple looking tool, but don't be fooled by its looks; a surface plate is a highly precisioned piece of equipment. In Machine Shop Operations and Setups, pages 74 and 75, the surface plate is discussed. Read this information and observe figure 37 on page 74. In your machine shop you have both the cast iron and black granite plates.
   a. What is the serious limitation of the cast iron plate?________

   ____

   b. Granite plates are replacing cast iron plates for two reasons. What are these reasons?

      a. ____

      b. ____

LEARNING ACTIVITY (cont'd):

3. Angle plates are used along with the surface plate. Page 83 of the same reference tells about these angle plates, and figures 51 and 52 show the angle plates and the ways in which they are used.

   a. The angle plate is usually formed in the shape of a ________ angle and this angle has _______ degrees.

4. The surface gage is normally used with the surface plate and sometimes with angle plates. The surface gage parts can be learned in a few minutes, but it takes time and skill to learn to use the surface gage to an accuracy of ± 1/32nd of an inch. You will begin to develop this skill in this task package. To learn about the surface gage read section 89, pages 57 and 58, in Metalwork Technology and Practice. Also read the section entitled Surface Gage in Machine Shop Operations and Setups, pages 83 and 84. On page 83 of this same reference there is a picture, figure 53, showing three tools. Fill in the names of these tools in the spaces below.

   a. ________________ ______________

   b. ________________ ______________

   c. ________________ ______________

5. There are other uses for the surface plate. These you will learn as you continue your work in the machine shop. By watching other people use this and other tools, you will gain new skills and knowledge. Another way to increase your knowledge is to start a

LEARNING ACTIVITY (cont'd):

small library of your own. Reference materials are available at a small cost and some are even free. These task packages can serve as the beginning of your library.

6. Have your instructor check your work. You also can ask him about materials for your library. If you have completed your learning activity go to the machine shop and start the learning practice.

LEARNING PRACTICE:

Tools and Equipment

1. Surface Gage
2. Surface Plate
3. Angle Plate
4. Combination square head and blade
5. Layout fluid
6. Clamps

1. From your instructor, obtain a piece of flat metal 6" x 6". Color it with layout fluid and clamp it to the angle plate. See figure 52, page 82, Machine Shop Operations and Setups.
2. Place the angle plate on the surface plate. Make sure the surface plate and the bottom of the angle plate are clean.
3. Making sure the bottom of the surface gage is clean, place it on the surface plate.
4. With the scribing point of the surface gage scribe a line across the workpiece around the middle of it. You do not need to measure this. Just make a good guess.

LEARNING PRACTICE (cont'd):

5. Make 4 parallel lines at different heights above your first line. (You now have five lines on the workpiece.)
6. Reset your scriber point to the first line you made. Use the fine adjustment screw to align the scriber point. Using the combination square head and blade (see figure 53, page 83 in Machine Shop Operations and Setups.) Measure the height of this line and also the other 4 lines to the nearest 1/32nd of an inch. Place the measurements below:

   a. b. c. d. e.
7. Draw four lines below your first line and parallel to it. Each line is to be 5/32nd of an inch from the other.

You have now learned to measure and scribe lines accurately with a surface gage. As you work around the machine shop you will learn more about this versatile tool.

Have your instructor check your work, and if it is completed, clean and replace your tools.

You've come this far, Charlie Brown! Try another package.

UNIT I: MEASURING DEVICES

TASK PACKAGE #7: MICROMETER

PREREQUISITE: UNIT I, TASK PACKAGE 6

RATIONALE:

At last you have arrived at the point where you will learn to do precision measuring. This is the area of measurement that you, as a machinist, will be working in most of the time. This is where you leave the larger fractions of an inch and start working with thousandths of an inch. When you make a fraction out of one-thousandth of an inch it looks like this: 1/1000. That's dividing an inch into a thousandth, a part so small you can hardly see it. If this seems small, remember that the inch can be divided into even much smaller parts, but this type of measuring will be saved until some later day when you have more experience in the machine shop.

The tool you will be using to make these precision measurements is called the micrometer caliper and dates back to 1851, when a man named Joseph R. Brown invented an instrument that could measure one-thousandth of an inch. Later improvements on this instrument gave birth to the micrometer caliper. Now a little over a hundred years later you are about to learn about this precision measuring

RATIONALE (cont'd):

tool. And you can decide how well you enjoy precision work.

It won't be easy, but you can do it!

OBJECTIVE:

Upon completion of this task package you will be able to use an outside micrometer caliper to measure the diameter of a rod, the thickness of sheet metal, and the length of stock within the capacity of the instrument. A standard of accuracy of ± .001 of an inch will be required.

LEARNING ACTIVITY:

1. View the slide-sound programs #M-I-7 and M-TT-15.
2. You will need a new mathematics skill for this task package. If you have trouble with decimals you will want to review Mathematics for Vocations, packages 6 and 7. You may want to try the pretest in these packages to see how sharp your math skills are.
3. There is ample reading material in your reference books on the subject of the micrometer caliper or "mikes" as they are commonly called. In this task package some of this material will be listed, but the main reference will be in Machine Shop

LEARNING ACTIVITY (cont'd):

Operations and Setups, pages 18 through 28 up to the section entitled Inside Micrometer Caliper. Included in this reading activity on page 21 is a section on Metric Measure. This is included now just for your information. In a few years it is very possible that we will all have to learn this system of measurement, but in the meantime let's stick to the U. S. decimal system and use it.

4. If you feel after reading the above pages, that some information is not clear, take a look at these additional reference materials:
    a. Machine Tool Technology, Units 7 and 8, pages 61 to 67.
    b. Metalwork Technology and Practice, Units 9 and 10, pages 73 to 83.
    c. Technical Metals, Section 12, pages 315 to 319.

5. Opposite page 22 in Machine Shop Operations and Setups is a series of pages lettered A through F. Study these pages along with the text, and answer the following questions:

Page A. (1) The spindle screw has __________threads per inch. (See page 23)

(2) Is the spindle screw labeled on page A? ________

NOTE: Some micrometers do not have a ratchet assembly on them.

Page B. (1) The first two readings of the micrometer are taken from the ______________________________

LEARNING ACTIVITY (cont'd):

(2) The last reading is taken from the ___________

(3) The spindle moves _____________with each complete turn.

(a) Twenty-five hundredths of an inch.

(b) Twenty-five tenths of an inch.

(c) Twenty-five thousandths of an inch.

(d) Twenty-five ten thousandths of an inch.

Page C. (1) The mark on the thimble that is aligned with the mark on the barrel is read as ________ of an inch.

Page D. (1) The reading on the micrometer is for five ten-thousandths of an inch, but this is not a precision measurement. To make a precision measurement of this small an increment, a vernier scale is used. An example of this scale may be seen in figure 19, page 26.

Pages E. and F. (1) These two pages will give you some help in reading the micrometer. Try covering the numbers at the bottom of the page and read the drawings. If you have trouble with this exercise keep working at it. It is very important that you learn to read the micrometer.

6. Figures 1, 2, 3, and 4 in this task package are pictures of

LEARNING ACTIVITY (cont'd):

micrometers. Figures 3 and 4 show micrometers with a vernier scale. Do not try to read the vernier scale; instead read the regular scales and write down the answers in the blanks below.

figure 1._______ figure 2. _______ figure 3. _______ figure 4._______

7. Have your instructor check your work and if it is correct start your Learning Practice.

LEARNING PRACTICE:

Tools & Equipment

1. 0-1" Micrometer caliper 2. Paper and pencil

1. Obtain from your instructor:
   a. Three pieces of round stock of different diameters, but less than 1" in diameter.
   b. Three pieces of sheet metal of different thicknesses.
   c. Three pieces of stock of different lengths, but less than 1" inch in length.
2. Measure and record the micrometer readings in the blanks below:

Rod Diameter	Metal Thickness	Rod Length
a.	a.	a.
b.	b.	b.
c.	c.	c.

3. For your own experience pick out other objects and measure them. You might try a pencil, this sheet of paper, some coins,

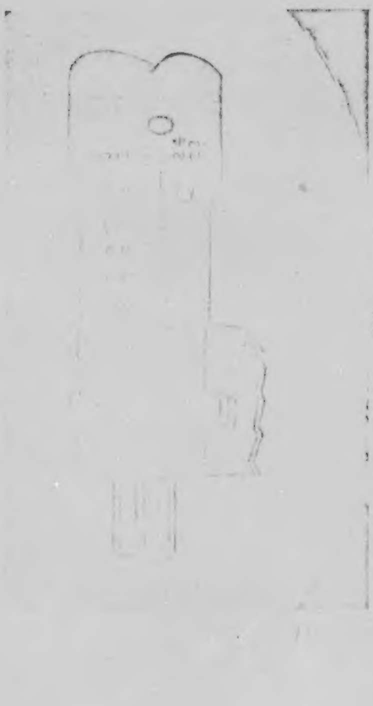


Figure 1

ANS. ____________

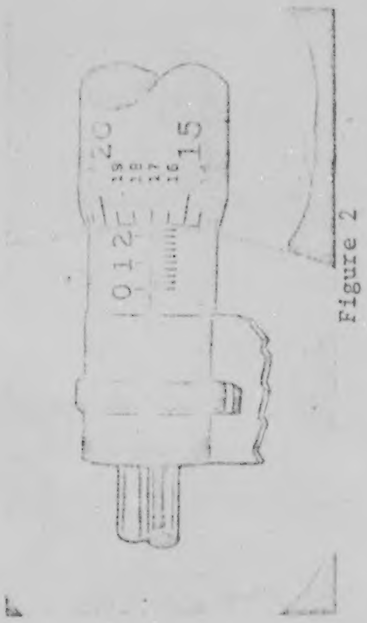


Figure 2

ANS. ____________

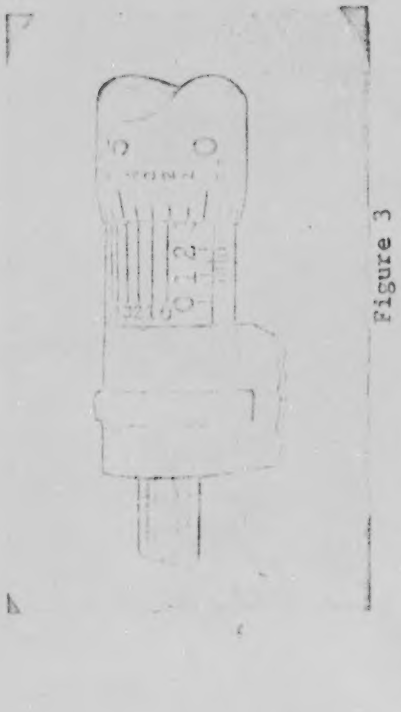


Figure 3

ANS. ____________

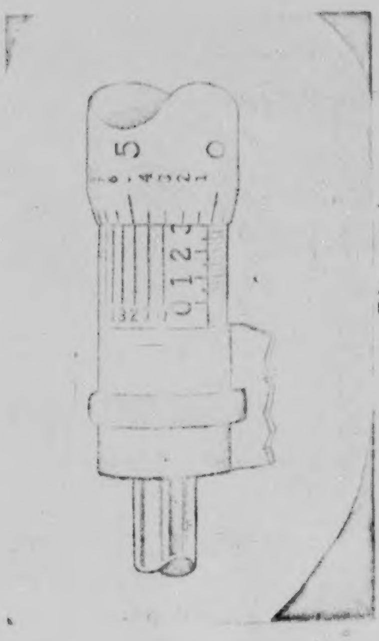


Figure 4

ANS. ____________

LEARNING PRACTICE (cont'd):

or other objects. Show your friends how you can measure to a thousandth of an inch.

4. Now show your instructor how well you can use the micrometer caliper. By the way, can you spell it?

This has been a hard task package, but when you have completed it you have earned the right to be proud of your competency. Keep at it; you're doing a good job!

M-I-7A

UNIT I: MEASURING DEVICES

TASK PACKAGE 7A: METRIC MICROMETER

PREREQUISITES: UNIT I, TASK PACKAGES 6 AND 7

RATIONALE:

Since there is so much importance placed on precision measuring in the machine trades, it would be to your advantage to become familiar with the metric system. With practically all of the non-English-speaking countries using the metric measuring system, it is important to the American producers to eventually use this system. Legally, the metric system is the only system of measurement set down as acceptable by the Federal Government.

Today, the metric system is used extensively in aero-space vehicle manufacturing, drug manufacturing, and other areas of manufacturing. In a few short years, the entire industrial might of America will be converted to this system.

This is just another opportunity for you to learn and grow with this age of ever-changing modern mechanical technology.

OBJECTIVE:

Upon completion of this task package you will be able to use an outside metric micrometer to measure the diameter of a piece of round bar stock, the thickness of a piece of sheet metal and the length of stock within the capacity of the instrument. Acceptable accuracy will be held to within two decimal places.

LEARNING ACTIVITY:

1. Read on pages 34 and 35 in Machine Shop Operations and Setups the paragraphs entitled The Metric Micrometer and Reading the Metric Micrometer.
2. To better understand the metric micrometer, it would be to your advantage to read chapter 3, called Systems of Measurement in Fundamentals of Dimensional Metrology.
3. View sound-slide program M-I-7A.
4. On page 44 of Fundamentals of Dimensional Metrology, answer questions:

   1.

   3.

   4.

   7.

LEARNING ACTIVITY (cont'd):

9.

11.

15.

4. Answer discussion topic 4.

4.

5. In your own words write the meaning of Abbe's Law.

LEARNING PRACTICE:

Tools & Equipment

1. Metric micrometer
2. Paper and pencil

1. Obtain from your instructor:

    A. Three pieces of round stock of different diameters, but less than 1" in diameter.

    B. Three pieces of sheet metal of different thicknesses.

    C. Three pieces of stock of different lengths, but less than 1" long.

2. Measure and record the micrometer readings in the blanks below:

Rod Diameter	Metal Thickness	Rod Length
A.	A.	A.
B.	B.	B.
C.	C.	C.

3. For other practice, pick out other objects and measure them. You might try a piece of paper, some coins, or various sizes of wire.

4. Demonstrate to your instructor your ability to measure objects with a metric micrometer. To have a better understanding of the methods of measuring and what is involved, it will be to your advantage to read chapters 1, 2, 3, and 4 in Fundamentals of Dimensional Metrology.

UNIT I: MEASURING DEVICES

TASK PACKAGE #8: INSIDE AND OUTSIDE CALIPERS

PREREQUISITES: UNIT I, TASK PACKAGE 7

RATIONALE:

In the last task package you used the micrometer for the primary measuring tool. In this package you will use two other tools, inside and outside calipers, to take the measurement and then use the micrometer to read the measurement you have taken. Remember what you have learned about the micrometer and, if you are a bit "fuzzy" on it, go back and review the last package.

You will see as you progress through the Learning Activity that the caliper increases the number of measuring jobs that the micrometer can do. You might almost say that calipers are extensions of the micrometer.

Again, as with all the tools you learn to use successfully, the caliper will increase your chances of becoming a good craftsman, and there may be no greater title than that of a good craftsman. The skilled craftsman is respected by all men! Do you, yourself, have the mettle to develop fine craft skills?

OBJECTIVE:

Upon completion of this task package you will be able to use inside and outside spring calipers and micrometers to measure tubing diameters. A standard of accuracy of ± .001 of an inch will be required.

LEARNING ACTIVITY:

1. View sound-slide program M-I-8.
2. The sound-slide program should have given you some ideas about how calipers are used. Now do some looking and reading in your reference material, and maybe you will find even more ways these tools can be used. In Machine Tool Technology, page 54, figure 3-15, a selection of calipers is shown. These are all inside and outside calipers, but they are not all spring calipers. The name for those at C and F are firm joint calipers. More information about these tools is covered in Unit 7 of the same book. Read the information on page 67 and then read the sections up to Procedure for Setting the Hermaphrodite Caliper.

   a. Write the two CAUTIONS in the spaces below:

      (1)____

      (2)____

LEARNING ACTIVITY (cont'd):

3. In Metalwork Technology and Practice, pages 53 and 54, read sections 67 through 73 (these are short) and look at figures 44 through 48.
4. Machine Shop Operations and Setups also has information on the caliper starting on page 15 and ending on page 18. Read these pages and take a good look at figure 15, page 17.
5. When you have seen and read the reference material and written the two cautions, check with your instructor and start the Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Inside caliper
2. Outside caliper
3. Micrometer
4. Pencil or pen

1. Three pieces of tubing of different diameters will be needed for this practice. Make sure the inside diameter of the smallest tube is large enough for the inside caliper to be used. (There are other methods for measuring smaller inside diameters. Can

LEARNING PRACTICE (cont'd):

you find them in your reference material?)

2. Measure the inside and outside diameters of the tubing and list the measurements below: Remember ± .001 of an inch for accuracy!

	Tube 1	Tube 2	Tube 3
Inside	(a)	(a)	(a)
Outside	(b)	(b)	(b)

3. Using the caliper for measuring and transferring these measurements from caliper to caliper, or from caliper to micrometer, is not an easy skill to learn. You must develop a sense of touch, and this takes time. But you will be able to do it when you have had more experience in the machine area.

4. Show your instructor how well you can use the calipers and the micrometer. When he is impressed with your skill he will reward you by letting you do the next task package.

M-I-9

UNIT I: MEASURING DEVICES

TASK PACKAGE #9: THE TELESCOPING GAGE

PREREQUISITE: UNIT I, TASK PACKAGE #8

RATIONALE:

You may not have been satisfied with the results of measuring inside diameters with the caliper and micrometer in the last task package. If not, then the telescoping gage should make life a bit better for you and increase your ability to measure the inside diameter of workpieces.

After working with the telescoping gage, you will notice an increase in the accuracy and the ease with which you can measure inside diameters. This, of course, will increase the speed and efficiency of your job and produce a more craftsman-like product. Keep striving for craftsmanship; it will earn you big dividends later!

OBJECTIVE:

Upon completion of this task package you will be able to use telescoping gages and micrometers to measure inside diameters. A standard of accuracy of ± .001 of an inch will be required.

LEARNING ACTIVITY:

1. View the sound-slide program M-1-9.
2. Read the following assignments in your reference materials:
   a. Machine Shop Operations and Setups, pages 234 and 235, Telescoping Gages. Also look at figure 85 on page 235.
   b. Metalwork Technology and Practice, page 450, section 1155, and observe figure 958.
   c. Machine Tool Technology, page 59, the section entitled Telescoping Gages, and notice figures 3-35 and 3-36.
3. You should now be ready to advance to your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Telescoping gages
2. Micrometer
3. Pencil or pen

1. Obtain three pieces of tubing from your instructor in different diameters. Make sure the smallest inside diameter is large enough for the smallest telescoping gage to fit into it. If they are satisfactory, you may want to use the pieces of tubing that you used for the Learning Practice in the last task package, and then compare the readings.

LEARNING PRACTICE (cont'd):

2. Measure the inside diameters of the tubing and record these readings below. You should be accurate to ± .001 of an inch.

a. b. c.

NOTE: Measurements other than inside diameters can be made with the telescoping gage. Find some objects around the machine shop and measure them.

This has been a short task package, but it does not mean that learning to use the telescoping gage is not important. This tool increases your ability to measure more accurately. You have learned another skill and one that you can make pay off, with some practice.

See your instructor and show him what you have learned; if you're both happy, pick up the next task package.

M-I-10

UNIT I: MEASURING DEVICES

TASK PACKAGE # 10: DEPTH MICROMETER

PREREQUISITES: UNIT I, TASK PACKAGE # 9

RATIONALE:

You know how to use precision measuring tools to measure inside and outside diameters, lengths, and thicknesses. In this task package you will learn to measure the depths of holes and grooves. Combining these measuring skills still does not give you the complete range of measuring skills that you will need to perform efficiently in the machine shop, but don't get impatient; with the completion of this and a few more task packages you will soon be ready to run a number of the machines in the shop.

The depth micrometer will allow you to measure the depths in a workpiece to 1/1000th of an inch. This skill will allow you to do much more accurate work and make you a more precise craftsman. Keep practicing and, when you become a skilled craftsman, you will be the envy of your peers.

OBJECTIVE:

Upon completion of this task package you will be able to use a depth micrometer to measure open and blind holes, grooves, and slots. A standard of accuracy of ± .001 of an inch will be required.

LEARNING ACTIVITY:

1. View sound-slide M-TT-15.
2. Reading assignments for the depth micrometer will be found in the following reference sources:
   a. Machine Shop Operations and Setups, pages 31 and 32.
   b. Metalwork Technology and Practice, pages 75 and 79.
   This is review reading, but it will probably be more meaningful now.
3. Notice that the scale on the barrel of the depth micrometer is opposite the scale on the micrometer caliper. If you think about it, you can see why this is true. Don't let it trouble you; the depth micrometer scale is read just like other micrometers. If you can read one micrometer, you can read them all.

LEARNING ACTIVITY (cont'd):

4. One more item of information: don't forget to add the length of the measuring rod when you use the depth micrometer.

5. Since there is very little new material in this task package there will be no written Learning Activity. Instead, go on to the Learning Practice.

LEARNING PRACTICE:

Tools & Equipment

1. Depth Micrometer
2. Pencil
3. Surface Plate

1. From your instructor, obtain a block of metal with five blind holes and an open hole drilled into it.

2. Measure the depth of the blind holes and mark the measurements down in the blanks below:

   a. ______ b. ______ c. ______ d. ______ e. ______

3. Clean the bottom of the block and place it on the surface plate. Measure the distance from the top of the block to the surface plate. You have just measured the thickness of this block. How thick is the block?______________________________

LEARNING PRACTICE (cont'd):

4. Now obtain a block with three grooves in it from your instructor. Measure the depth of these grooves at each end of the block. Do these grooves vary in depth? _______ What is the depth of each groove?

   a. ______________ b. ______________ c. ______________

5. Check your answers with your instructor. If they are right, carefully clean and put away your tools. You have completed this task package successfully. Congratulations! You are doing a good job.

M-I-11

UNIT I: MEASURING DEVICES

TASK PACKAGE #11: VERNIER GAGES

PREREQUISITES: UNIT I, TASK PACKAGE 10

RATIONALE:

Another in the long list of useful measuring tools is the vernier gage or gages. There are several different gages, but the nice thing about them is that once you have learned to use one type of gage the others are about the same - as far as reading them, that is.

It is the reading of the vernier scale that is the difficult skill to learn, but don't become uneasy about it; you have already learned many difficult tasks. Once you learn and understand the vernier scale you will never forget it.

Now is the time to get started on learning the vernier scale. Take your time; understand what you are doing; keep plugging away at it. Remember the end is only a few pages away!

OBJECTIVE:

Upon completion of this task package you will be able to use vernier gages to measure heights, lengths, widths, and inside and outside diameters of stock. A standard of accuracy of ± .001 of an inch will be required.

LEARNING ACTIVITY:

1. View slide-sound program M-I-11.
2. Learning to read the vernier scale will be the hardest part of this task package. Using the various gages will just be repeating what you already know. This being so, we will concentrate on the vernier scale and how to read it.
3. Start your reading with the reference book Machine Tool Technology, Unit 11, pages 77 to 81. Do not, at this point, read about the Universal Bevel Protractor.
4. Next read The Vernier Caliper, page 35, in Machine Shop Operations and Setups. Also read the remainder of page 35 and pages 36 and 37. Study the picture and illustrations very carefully in these reading assignments. Notice on page 38

LEARNING ACTIVITY (cont'd):

there are four examples of reading the vernier scale. Study these carefully.

LEARNING PRACTICE:

Tools and Equipment

1. Vernier height gage	3. Pencil or pen
2. Vernier caliper	4. Surface plate

1. Obtain the following from your instructor:
    a. Three blocks of steel - different heights
    b. Three pieces of flat stock - different lengths and widths
    c. Three pieces of tubing - different lengths and diameters
2. Measure the stock obtained and record the measurements:
    a. Blocks of steel

        Height

        (1)

        (2)

        (3)
    b. Flat stock

LEARNING PRACTICE (cont'd):

	Length	(1)	(2)	(3)
	Width	(1)	(2)	(3)
c.	Tubing			
	Inside Diameter	(1)	(2)	(3)
	Outside Diameter	(1)	(2)	(3)
	Length	(1)	(2)	(3)

When you have advanced in your package this far you should have a good idea of how to use the vernier scale. You might want to go back and check your measurements again just to be sure you understand all the material you have covered. When you are sure of your measurements, let your instructor check your work.

This has been a very hard task package. You deserve congratulations for doing a good job. But don't stop now! Dig in and get another task package.

M-I-11B

UNIT I: MEASURING DEVICES

TASK PACKAGE 11B: METRIC VERNIER CALIPERS

PREREQUISITES: UNIT I, TASK PACKAGE 10

RATIONALE:

Now that you have been successful in learning to read and use a vernier caliper calibrated in English measurement, you will find the transition to reading a metric caliper somewhat similar. The use of the metric system is extremely important to us today, and in the near future practically every industry in America will be using this system.

Presently, America is one of five major nations in the world market not using the metric system. Even though the metric system is the only legal (that is passed by congressional law) system in our country, somehow it has never been enforced. The sad result of this gross error is going to cost our country billions of dollars.

Again, here is an opportunity for you to learn and be part of the great industrial transition facing us.

OBJECTIVE:

Upon completion of this task package you will be able to use a metric vernier caliper to measure heights, lengths, widths, and inside and outside diameters of stock. The standard of accuracy will be two decimal places.

LEARNING ACTIVITY:

1. View sound-slide program M-I-11B.
2. Read Systems of Measurement, Chapter 3, in Fundamentals of Dimentional Metrology. Answer questions on page 44.

   1.

   3.

   4.

   7.

   9.

   11.

   15.

LEARNING ACTIVITY (cont'd):

3. Answer discussion topic questions 1 and 2.

   1.

   2.

4. Read page 82 in Fundamentals of Dimentional Metrology, the paragraphs The Vernier Caliper and Abbe's Law. Explain Abbe's Law in your own words.

LEARNING PRACTICE:

Tools & Equipment

1. Metric vernier caliper 2. Pencil and paper

1. Obtain the following from your instructor:
   a. 3 blocks of steel of different heights.
   b. 3 pieces of flat stock of different thicknesses.
   c. 3 pieces of tubing of different diameters.
2. Measure the stock obtained and record the measurements.
   A. Blocks of steel:

      1. 2. 3.

   B. Flat stock:

      1. 2. 3.

   C. Tubing:

	Inside	Outside	Overall Length
1.			
2.			
3.			

3. When you are confident that you can read a metric vernier caliper, demonstrate your skill to your instructor. To have a better understanding of measuring methods, it would be to your advantage to read chapters 1, 2, 3 and 4 in Fundamentals of Dimensional Metrology.

M-I-12

UNIT I: MEASURING DEVICES

TASK PACKAGE # 12: DIAL INDICATOR AND GAGE BLOCKS

PREREQUISITES: UNIT I, TASK PACKAGE 11

RATIONALE:

The gage blocks that you will be using in this task package to check the dial indicator are unpretentious looking pieces of steel. Don't let their looks fool you; these blocks represent one of the major breakthroughs in the history of measurement.

The first gage blocks were invented by Carl Edvard Johansson in 1896 at Eskilstuna, Sweden. With his blocks Johansson was able to measure to within millionths of an inch. How large or small, depending on the way you think of it, is a millionth of an inch? If you could take one of the hairs in your head and slice it lengthwise into 3000 slices, each slice would be about a millionth of an inch. Hard to even think that small, isn't it? You will hear the term Jo-blocks used around the machine shop when machinists refer to gage blocks. Of course you know where the term comes from!

When working on machines you will be employing the dial indicator for many purposes. It is very easy to use and it increases your ability to do more accurate work. You should find the material in this task package very interesting and perhaps a little difficult but charge into it; you may find it's fun!

OBJECTIVE:

Upon completion of this task package you will be able to use precision gage blocks and a surface plate to check the accuracy of a dial indicator. The acceptable standard of performance will be an accuracy of ± .0005 of an inch.

LEARNING ACTIVITY:

1. View sound-slide program M-I-12 and M-I-11A.
2. Reading assignments for this task package will be somewhat long because two very important tools are involved. Start reading on page 70 in Machine Tool Technology and read to page 74. Notice in the pictures how the dial indicator is used. You will be doing some of these operations in later task packages.
3. In the same reference book read Unit 13, pages 85 to 91. This is your introduction to gage blocks and to measuring with extreme precision. Notice on page 90 in the upper left-hand column the precautions listed for using gage blocks. You must be very careful with these tools.
4. Machine Shop Operations and Setups, pages 41 to 45, is your next reading assignment. Figure 40, page 42, shows you the names of the parts of the dial indicator.

LEARNING ACTIVITY (cont'd):

5. Technical Metals, Unit 71, pages 325 to 333, covers both gage blocks and dial indicators.
6. Now go into your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Surface plate
2. Dial indicator set
3. Gage blocks
4. Pencil and paper
5. Vernier height gage

1. Set up the dial indicator for use on the surface plate by attaching it to the vernier height gage. If you have difficulty ask your instructor for help.
2. Set the vernier gage to the height of the shortest gage block and bring the dial indicator in contact with the lapped surface of the gage block. Check the dial indicator by moving it over the lapped surface and watch for deflection of the dial needle. Write down the amount of deflection.

NOTE: Did you clean all the mating surfaces with a clean cloth?

3. Repeat the above procedure using a new gage block.
4. Show your instructor the results of your tests.

LEARNING PRACTICE (cont'd):

5. Clean and lubricate the tools and return them to their proper places.

You have now used some very highly precisioned pieces of equipment. The dial indicator will be employed many times in the future, and on occasion you will be using gage blocks. Be proud of what you have accomplished so far. You're doing a good job!

M-I-13

UNIT I: MEASURING DEVICES

TASK PACKAGE #13: DIAL INDICATOR

PREREQUISITES: UNIT I, TASK PACKAGE 12

RATIONALE:

You have learned to test the dial indicator in your last package. Now you will learn to test a piece of stock with the dial indicator.

The dial indicator can be, and is, used on all the machines in a machine shop. As you progress through this course you will be asked to use the dial indicator to check and align workpieces on or off the machines. How well and how easily you can do this depends a great deal on how well you learn the basic lessons in your task packages.

Do a good job now and you will enjoy it later!

OBJECTIVE:

Upon completion of this task package you will be able to use a dial indicator, vee blocks, and surface plate to test the concentricity (roundness) of stock. A standard of accuracy of ± .001 of an inch will be required.

LEARNING ACTIVITY:

1. View slide-sound program M-I-13.
2. The vee blocks, also called V-blocks, are holding devices for roundstock. To find out something about them and how they are used, turn to page 59 in Metalwork Technology and Practice and read section 92. Figure 69 on the same page shows how the clamps are used with them. Now turn to page 210, figure 427, and see the v-blocks used in another way; page 578, figure 1287 also shows the v-blocks in use.
3. You will be using the dial indicator again in this task package, so turn to page 446 in Metalwork Technology and Practice and see some of the various uses of this measuring device. Read section 1152 on this and the next page and examine the pictures and illustrations. You are probably wondering why you are doing so much jumping around and [illegible]. The reason for this is that the work you do in a task package is usually a basic function of the tools and equipment. There are many other ways to use these tools and, while it may be sometime before you do use them, you should be aware of some of these uses.
4. Read the section on v-blocks in Machine Tool Technology, page 58, and notice figure 3 - 30.

LEARNING ACTIVITY (cont'd):

5. Machine Shop Operations and Setups, page 43, figure 41 shows a picture of the operation you will be doing in this task package. Study it and notice that you can use this operation to check tapers. This practice will be useful for a later task package.

NOTE: V-blocks should be purchased in pairs and the pairs should be kept together. Don't mix V-blocks.

6. Go into your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Dial indicator set
2. V-blocks and machinist's clamps.
3. Surface plate
4. Pencil and paper

1. Obtain from your instructor a piece of smooth roundstock about 6" to 8" in length.

2. Make the setup as shown in figure 41, page 43, Machine Shop Operations and Setups.

3. Test the concentricity of the roundstock at each end and at each 1/2 inch of the length. Record your readings on a piece of paper.

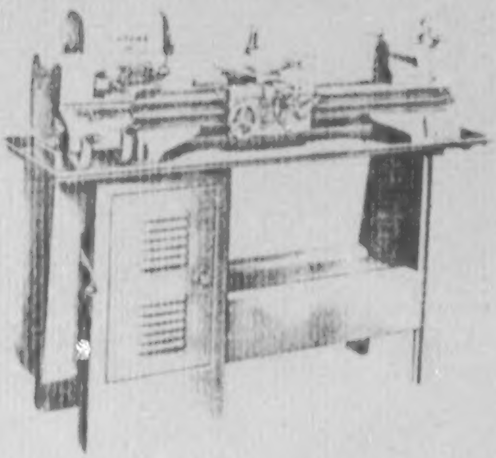
4. You may want to test other pieces of stock. If so, ask your instructor for some pieces to test.

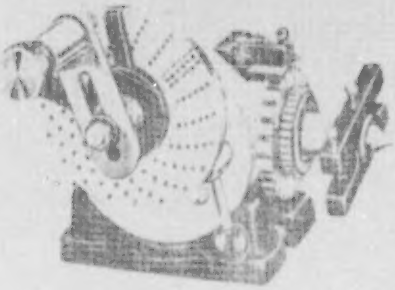
LEARNING PRACTICE (cont'd):

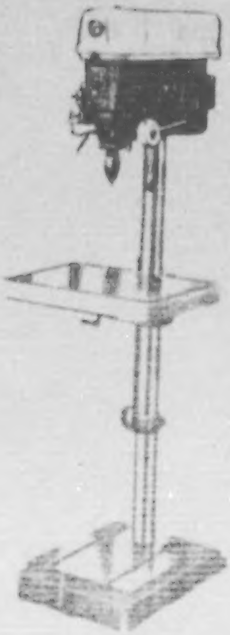
5. Show your work to your instructor and, if you have any questions, now is a good time to ask him about them.
6. When you have made the test, clean all the tools and replace them. Handle these tools very carefully as nicks or burrs can limit their usefulness.

You have completed the unit on measuring devices. While this has been a long unit it also is a very basic, but important, part of your introduction to the machine shop crafts. Remember in all your future work that you are becoming a craftsman, and to be a craftsman you must first be accurate!

RESEARCH PROJECT
SANFORD CENTRAL HIGH SCHOOL
1708 NASH STREET
SANFORD, NORTH CAROLINA 27330







CLUSTER: METALS

COURSE: MACHINE SHOP

OEC03793(6)

M-II

UNIT PACKAGE II: BENCH WORK

PREREQUISITES: M-I

RATIONALE:

The new machinist will usually start his career in the machine shop at a work bench. It is here that he is introduced to many of the hand tools that he will use throughout his working life. It is also here that he will incorporate the habits of accuracy and craftsmanship as his personal traits.

In this unit you will be exposed to a wide range of skills, each of which forms an important base for future machine shop work. You will learn about the art of filing metal, cutting metal, layout, threading, polishing and the inspection of parts. You will also do all of these things in the machine shop. With this learning and doing, you will be able to accomplish the general and specific objectives, in a step by step manner and at your own pace.

OBJECTIVES:

General:

Upon completion of this unit you will be able to do basic bench work in a machine shop. This work will include the use of hand tools to perform such operations as filing, cutting, layout, threading, polishing, and inspecting.

OBJECTIVES (cont'd):

Specific:

Upon completion of the task packages for this unit, you will be able to:

1. Select and use the correct cut of file, as described in Technical Metals, page 74, and file to a scribed line on steel and aluminum. Correct choice of file will be evaluated by the instructor's check list, and acceptable filing performance will be determined by an accuracy of + 1/32nd of an inch.
2. Use cold chisels and metal cutting handsaws to cut flat metal stock. Performance requirements involve an accuracy of + 1/16th of an inch.
3. Use layout tools to lay out points for drilling and lines for milling and turning. A standard of accuracy of 1/32nd inch will be required.
4. Use dies and diestocks to thread lengths of stock with right and left hand threads. A standard of accuracy of ± 1/32nd of an inch will be required for length of thread.
5. Use taps and tap handles to thread open and blind holes. The standard of acceptance for this operation is successfully inserting a bolt of the same thread size in the tapped hole.
6. Use abrasive cloth, lapping compound, and steel wool to polish parts by hand. Your performance will be evaluated in accordance with the instructor's checklist.

OBJECTIVES (cont'd):

Specific:

Upon completion of the task packages for this unit, you will be able to:

1. Select and use the correct cut of file, as described in Technical Metals, page 74, and file to a scribed line on steel and aluminum. Correct choice of file will be evaluated by the instructor's check list, and acceptable filing performance will be determined by an accuracy of + 1/32nd of an inch.
2. Use cold chisels and metal cutting handsaws to cut flat metal stock. Performance requirements involve an accuracy of + 1/16th of an inch.
3. Use layout tools to lay out points for drilling and lines for milling and turning. A standard of accuracy of 1/32nd inch will be required.
4. Use dies and diestocks to thread lengths of stock with right and left hand threads. A standard of accuracy of ± 1/32nd of an inch will be required for length of thread.
5. Use taps and tap handles to thread open and blind holes. The standard of acceptance for this operation is successfully inserting a bolt of the same thread size in the tapped hole.
6. Use abrasive cloth, lapping compound, and steel wool to polish parts by hand. Your performance will be evaluated in accordance with the instructor's checklist.

OBJECTIVES (cont'd):

7. Use scales, micrometers, verniers, and jo-blocks to inspect parts. The standard of accuracy will be determined from the part specifications of the drawing.

LEARNING ACTIVITY:

The task packages in this unit have been designed to be worked in sequence. Start with the task package on filing and build your skills through the package on inspection. Notice how the skills from one package will help you with the skills in the next one.

If you find something that you do not understand in the task package, ask your instructor, or the Resource Center Director. There are times when you may want to consult other members of your school. Do so, when you need help.

In the package you will be asked to view a sound-slide presentation, read and answer questions, and perform some practical exercises. The number and names of the task packages included in this unit are as follows:

TASK PACKAGE 1: FILING
TASK PACKAGE 2: HAND METAL CUTTING
TASK PACKAGE 3: LAYOUT
TASK PACKAGE 4: EXTERNAL THREADING
TASK PACKAGE 5: INTERNAL THREADING
TASK PACKAGE 6: HAND POLISHING
TASK PACKAGE 7: PARTS INSPECTION

LEARNING ACTIVITY (cont'd):

If after reading this far, you feel that you can pass a comprehensive test on the above material, see your instructor and take the unit post-test. You may, however, feel you can't do this so you will want to proceed to the text package. In either case, good luck and enjoy learning about [illegible] trade.

UNIT II: BENCH WORK

TASK PACKAGE #1: FILING

PREREQUISITES: UNIT I, TASK PACKAGES 1 and 4

RATIONALE:

The art of filing is one of the older skills in the machinist's trade. It's hard to tell how far back in history this art goes, but file-like tools have been found among Indian relics.

The files we use today look very much like the ones that were used hundreds of years ago, but there is a great deal of difference in today's files. The steel in the files that are used today is of much better quality and the cuts (you will learn about this word in this task package) of files are made with more precision. This makes the job of filing somewhat easier for today's machinists.

In the machine shop today filing is still an art and it's one that is used very often. It is an art or skill that you will need to develop to be a successful machinist. Try it; after a while you will probably like it!

OBJECTIVE:

Upon completion of this task package you will be able to select and use the correct cut of file, as described in Technical Metals, page 74, and file to a scribed line on steel and aluminum. Correct choice of file will be evaluated by the instructor's check list, and acceptable filing performance will be determined by an accuracy of + 1/32nd of an inch.

LEARNING ACTIVITY:

1. View slide-sound programs M-II-1 and M-II-1A.
2. Read Unit 10, pages 72 to 80, in Technical Metals.
3. Many people find filing a hard chore. The major reason for this is they are not able to select the proper file for the job they are doing, and also they don't know how to file. It will be to your advantage as a machinist to learn how to select a file and how to use it.
4. From the above reading assignment answer the following questions:

   a. List the five names of the parts of the file:

   (1) (2) (3) (4) (5)

   b. Name the four cuts of files by cutting edges:

   (1) (2) (3) (4)

LEARNING ACTIVITY (cont'd):

c. Name the four cuts of files by coarseness:

(1) (2) (3) (4)

NOTE: You have been asked to list the above cuts of files because this term causes some confusion when files are being discussed. You need both terms when ordering certain files. Notice Figure 10-7, page 75; it shows a double cut, bastard, machinist's file. Also remember there is a difference between double cut and second cut. This can be confusing.

6. Show the answers to the above questions to your instructor and then start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Files for filing steel and aluminum
2. Bench vise
3. Scriber
4. Layout fluid
5. Combination square

1. Obtain from your instructor a piece of steel and a piece of aluminum.
2. If necessary, color these pieces with layout fluid.
3. Scribe a line about 1/16th of an inch from one edge on each piece.

LEARNING PRACTICE (cont'd):

4. Select the file or files you are going to use on each piece of metal. Show your selection to your instructor before you start to file.
5. File both pieces down to the scribed line. Do not file below the line and do not file into the line. Your accuracy should be + 1/32nd of an inch. Can you file to + 1/64 of an inch? If so, do it and show your instructor how skillfully you can handle a file. By the way, does your file have a handle on it?
6. You have completed another task package and have done a fine piece of work. Try as hard on the next one. Hey!! Did you clean up your tools and working area?
7. Even Snoopy couldn't do it any better!

UNIT II: BENCH WORK

TASK PACKAGE #2: HAND METAL CUTTING

PREREQUISITES: UNIT I, TASK PACKAGES 1 AND 4

RATIONALE:

Cutting metals can sometimes be an awesome job, especially for those who don't know how to do it. In this task package you will learn two ways of cutting metal that are used in the machine shop when for some reason a machine is not available to do the cutting job. These methods can also be employed for cutting metal when you are working around the house or on a car.

When you have learned these metal cutting skills you will have added to your craftsmanship two more important items. Remember, though, you still have many more skills to acquire, but with some hard work and, most importantly, some hard thinking you will add these skills as easily as you have the other ones you have learned.

OBJECTIVE:

Upon completion of this task package you will be able to use cold chisels and metal cutting handsaws to cut flat metal stock. Performance requirements involve an accuracy of +1/16th of an inch.

LEARNING ACTIVITY:

1. View slide-sound program M-II-2 and audiovisual programs M-TT-7 and M-TT-9.
2. In Metalwork Technology and Practice, read Unit 13, pages 101 to 106. Notice on page 104, figure 193, the method of cutting sheet metal with a chisel. Also shown in this unit are other ways in which a chisel may be used to cut metal.
3. In this same Unit there are two very important safety precautions; can you list the sections these are in?

   a. b.
4. Also in Metalwork Technology and Practice, Unit 11, pages 84 to 90, there are many good hints for using the hand hacksaw. Study the pictures and illustrations very carefully and answer these questions.
   a. If a hacksaw blade has 18 teeth per inch, how many points will it have? ____________________
   b. Why should the saw kerf be wider than the thickness of the saw? ____________________
   c. The teeth in a hacksaw blade should point ____________ ____________________ the handle.
5. Your other reference material also has information on these topics. It is usually a good idea to go to more than one source when you need information.

LEARNING ACTIVITY (cont'd):

6. When you have completed your Learning Activity show your work to your instructor and then do your Learning Practice.

LEARNING PRACTICE:

Tools & Equipment

1. Flat chisel
2. Ball peen hammer
3. Goggles
4. Vise
5. Hacksaw
6. Combination square
7. Scriber
8. Layout fluid

1. Obtain from your instructor:
   a. 1 piece of sheet metal
   b. 1 piece of bar stock
2. Scribe a line 1" from and parallel to the top edge on the sheet metal.
3. Place it in the vise (see figure 193, Metalwork Technology and Practice.) and cut it just above the line.
4. Scribe a line across the width of the bar stock 1" from and parallel to the edge.
5. Continue this line around the bar stock.
6. Move in 1" from the line you have made and make another line around the bar stock. The material between the lines will be your part and the material outside the lines will be your waste.

LEARNING PRACTICE (cont'd):

7. Using the lines as guides, cut on the waste side of your first line. Do not cut into the line. Now cut on the waste side of the second line. Again do not cut into the line.
8. You should have a part at least 1" x 1". Do you?
9. Take your pieces to your instructor and show him your work.
10. Clean up your work area and put away your tools.

Another task package well done and some more skills acquired.

Gee, it's good to see you making such progress, Charlie Brown.

M-II-3

UNIT II: BENCH WORK

TASK PACKAGE #3: LAYOUT

PREREQUISITES: UNIT I, TASK PACKAGES 1, 3, 4, and 5

RATIONALE:

You will be called on to do many jobs in the machine shop. How many of these jobs you can do successfully will in a great measure determine your status in relation to the people you will be working with. While there is nothing wrong in not being able to do a job (if you are unable to do something say so; never try to bluff the boss), there are many tasks that are considered to be a basic part of the machine trade. One of these tasks is reading blueprints and another is making layouts. In this task package you will have a chance to develop your skills in both of these areas. Do the work carefully, ask your instructor questions if you don't understand something, and in a short time you will increase your chances of becoming a true craftsman.

OBJECTIVE:

Upon completion of this task package you will be able to use lay-out tools to lay out points for drilling and lines for milling and turning. A standard of accuracy of 1/32nd inch will be required.

LEARNING ACTIVITY:

1. View slide-sound program M-II-3.
2. It will be necessary for you to do some work in blueprint reading for this task package. Study Units 3 and 4 in Blueprint Reading for Machinists.
3. Read and study Section 7 in Technical Metals.
4. Metalwork Technology and Practice has three units for you to read and study. These are Units 6, 7 and 8. You are acquainted with all of the tools in Unit 6 except the prick and center punches and the trammel.
5. The trammel is used in much the same manner as the dividers, and for many of the same uses. However, with the trammel you can do much larger work.
6. On page 52 in Metalwork Technology and Practice, Figure 41, an illustration is shown of the prick and center punches. Notice the difference between the points of these two punches. The prick punch has a long, tapered point that will make a smaller, in diameter, depression when forced into a piece of metal. This punch is always used first when doing layout work and is employed in the manner shown in Machine Shop Operations and Setups, page 86, Figure 56. If you lean the prick punch, placing its point on the intersecting lines and moving it to an upright position

LEARNING ACTIVITY (cont'd):

before striking it, your punch mark will be much more accurate. Before drilling any holes, and after checking your work carefully, you then use the center punch to enlarge the punch mark for drilling.

7. In Machine Shop Operations and Setups, pages 84 and 85, read the section, Location of Holes to be Drilled.

   NOTE: Before using any hammer, make sure the head is on the handle firmly. Do not take chances with tools! This has been a lot of reading and thinking so it's time to put your hands to work. Go to the Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Necessary layout tools
2. Layout fluid
3. Ball peen hammer
4. Center and prick punches

1. Obtain from your instructor a piece of flatstock at least 4" by 6".
2. Lay out a 4" by 6" rectangle.
3. Locate holes for drilling and prick punch these locations at the following points on the rectangle you have drawn:
   a. At a corner (it does not matter which corner) 1/2 inch in from each line, make an intersection of your lines.

LEARNING PRACTICE (cont'd):

   b. At the diagonal corner 19/32nds of an inch from each line, make an intersection of your lines.
   c. At another corner 3/4ths of an inch from each line, make an intersection.
   d. At the last corner 13/16 of an inch from each line, make an intersection.

4. Scribe two parallel lines the length of the piece and 1/2 of an inch on each side of a center line. (Make the center line first, then the lines parallel to the center line.)
5. Make the same layout across the width of the piece.
6. Now show your work to the instructor and, if it is correct, clean up, put away your tools, take a short break and tackle the [illegible] task package.
7. A task package is better than a security blanket, Charlie Brown!

UNIT II: BENCH WORK

TASK PACKAGE #4: EXTERNAL THREADING

PREREQUISITES: UNIT I, TASK PACKAGES 1 and 2; UNIT II, TASK PACKAGE 1

RATIONALE:

If you take a look around you and carefully observe the objects in the room you are in, you will see that many of them are put together with threaded fasteners. Have you ever wondered how the threads were made? This task package will give you the answer to that question and many other items of information about threads.

In this task package the subject is external threads. These are the threads that are cut on a rod or a piece of roundstock. If you own a bicycle, car, wagon or just about any object, you own some external threads. (These are not the kind of threads you wear, Charlie Brown!)

The machinist is called on many times to thread stock. You, as a machinist, will also be asked to cut threads, now and in the future. So dig into this task package and start cutting!

OBJECTIVE:

Upon completion of this task package you will be able to use dies and diestocks to thread lengths of stock with right and left hand threads. A standard of accuracy of ± 1/32nd of an inch will be required for length of thread.

LEARNING ACTIVITY:

1. View slide - sound program M-II-4.
2. Units 31 and 32, pages 230 to 244, in Metalwork Technology and Practice have a very good coverage on the subject of threads and threading. Read these two units carefully and also observe closely figures 472, 476, 477, 478, 497, 498, 499, 500, and 501. On page 236 see table 19; you will need this or a similar table when doing thread work.
3. List below the captions (the words after the figure number) of the nine figures listed above. Do not include the table.

a.

b.

c.

d.

e.

f.

LEARNING ACTIVITY (cont'd):

g.

h.

i.

4. Read Units 21 and 22 in Machine Tool Technology.
5. You now have some knowledge of external threads and threading. Show your work to your instructor and do your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Dies and diestock
2. Files
3. Thread gage
4. Combination square
5. Threading oil
6. Scriber

1. Obtain from your instructor 3 pieces of roundstock of different diameters.
2. On two pieces of stock cut a UNC and UNF thread on each end. Make these threads an inch in length.
3. On the third piece of stock cut left hand threads. Make these threads one inch in length.
4. Inspect the threads you have made. Put nuts on those that you can.
5. Show your work to your instructor. If he approves of your work put away your tools and clean up your area. You may want to show your friends what a good job you

LEARNING PRACTICE (cont'd):

have done. If you have any drunken threads you may want to hide these. You know, of course, what a drunken thread is.

M-II-5

UNIT II: BENCH WORK

TASK PACKAGE #5: INTERNAL THREADING

PREREQUISITES: UNIT I, TASK PACKAGES 1, 4, 7, 8, 9 and 10

RATIONALE:

You know how to put threads on a rod. Now you will learn to put threads in a hole so you can insert the rod. These threads in a hole are called internal threads, and of course, this is because they are inside the hole.

There are as many uses for internal threads as there are for external threads. Look around you and see if you can find some of these uses. Remember how you put a light bulb in a socket? The socket has internal threads. Putting a nut on bolt involves both the external thread on the bolt and the internal thread on the nut. When you own a car you also own hundreds of internal threads. As you can see, threads are important to all of us, but they are more important to you, because you will be cutting them as one of your skills as a machinist.

Sharpen your skills by cutting threads!

OBJECTIVE:

Upon completion of this task package you will be able to use taps and tap handles to thread open and blind holes. The standard of acceptance for this operation is successfully inserting a bolt of the same thread size in the tapped hole.

LEARNING ACTIVITY:

1. View slide-sound program #M-II-5.
2. Metalwork Technology and Practice, Unit 33, pages 244 to 250, has some very good basic information on using taps. A section of this unit that is very important to you is section 652, Tap Drills. Understand this section before you go on to the next Learning Activity. Ask your instructor to explain it if you do not understand the concept of the tap drill size.
3. Machine Tool Technology, Units 23 to 27, pages 125 to 133, go into greater depth about tapping. If you are thinking that there is a lot more to threading than most people realize, you are thinking correctly. Besides the skills needed to do the threading, there is a large body of science involved with the theory of threads. Unit 26, Selection and Calculation of Tap Drill Size, is at this time "nice to know" information. Later on in your machinist's career, it will become "need to know" information.

LEARNING ACTIVITY (cont'd):

For the present, use charts such as the one in Metalwork Technology and Practice, page 246, for selecting the proper tap drill size.

NOTE: Use the tap drill size drill bit, to check the hole size.

4. Machine Tool Operations and Setups, pages 59 to 65, has more information on tapping. On pages 62 and 63 it tells how to select the tap drill size and also how to tap a hole.
5. When you have finished the reading assignments and you feel you have an understanding of this subject, go on to the Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Taps of the following sizes
   a. 1/4-28 UNF
   b. 1/4-20 UNC
   c. 1/2-20 UNF
   d. 1/2-13 UNC
2. Tap handles
3. Layout tools
4. Layout fluid
5. Threading oil
6. Ball peen hammer
7. Prick and center punches

1. Obtain from your instructor a piece of flatstock at least 1/4" thick.
2. Lay out a series of four holes at least 3/4" apart and number them.
3. Have your instructor drill the four holes, two of them blind, with the drill bits you have selected. He will at this time

LEARNING PRACTICE (cont'd):

check your selection of the tap drill size.

4. After the holes have been drilled, tap them with the proper size tap.
5. Find the proper size bolts and insert them in the holes. Do they fit? Are they straight? Can you insert them all the way?
6. Show your work to the instructor with the bolts in it.

Another task package is completed. New skills have been learned that will stand you in good stead in the years to come. Keep developing these skills as they are helping you to become a craftsman.

It's not the Great Pumpkin, Charlie Brown! It's on to another task package.

UNIT II: BENCH WORK

TASK PACKAGE #6: HAND POLISHING

PREREQUISITES: NONE

RATIONALE:

In other task packages, you have concentrated on making your workpiece as accurately as possible. This accuracy is the sign of a good craftsman, but it is not the only way that craftsmanship is judged. Another way of expressing yourself as a craftsman is to insure neatness in your work. Many times when doing machine operations, the machining takes care of the appearance of the final product, but there are times when you, as a skilled craftsman, must put the final touches to the workpiece. Hand polishing is a method of giving the part the necessary appearance of good craftsmanship.

Besides appearance, hand polishing is sometimes used to make workpieces fit together when very exact tolerances are required. To do this kind of work requires a great deal of skill, and in this task package you will start to develop this skill.

Brighten your world by hand polishing!

OBJECTIVE:

Upon completion of this task package you will be able to use abrasive cloth, lapping compound, and steel wool to polish parts by hand. Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View sound-slide program M-II-6.
2. Unit 66, page 294, in Technical Metals is your first reading assignment. In the list below fill in the grit number for the following:
   a. (1) Coarse:____________
   (2) Medium coarse:__________
   (3) Medium fine:__________
   (4) Fine:______________
   (5) Very fine:__________
   (6) High polish:__________
   b. What is the coarsest grade of steel wool?
   (1) ______________________________
   c. Name two of the synthetic abrasives that have replaced emery.
   (1) ______________________________
   (2) ______________________________
3. Metalwork Technology and Practice, Unit 17, pages 122 to 130, contains more information on hand polishing. Notice on page 128 under the topic Coordination, there is a list of words you should know. Besides his knowledge of the machinist's skills, a good

LEARNING ACTIVITY (cont'd):

machinist can communicate using the language of his trade.

How is your machinist's vocabulary?

LEARNING PRACTICE:

Tools and Equipment

1. Abrasive cloth (several grades)
2. Steel wool
3. Lapping compound
4. Light oil

1. Obtain from your instructor a piece of metal or a part that needs polishing.
2. Using the proper procedures, and instructions from your instructor, polish the workpiece.
3. Have your instructor evaluate the finished job.
4. Clean up your work area and put away your materials.

Now that you know how to hand polish you will find many uses for this skill.

Remember: A good craftsman makes his work look good!

M-II-7

UNIT II: BENCH WORK

TASK PACKAGE #7: PART INSPECTION

PREREQUISITES: UNIT I, TASK PACKAGES 1-13

RATIONALE:

Hey, Charlie Brown, I need you over at the inspection table! If the boss tells you this, you want to be ready to take on this new job. It may mean a promotion and better pay, or at the very least that the boss has been watching your work and thinks you have the skills for this kind of a job.

This task package will introduce you to the idea of inspection and to the broader world of quality control. You or someone in your family has had the experience of buying something new, taking it home, and finding out it wouldn't work properly. Right? The inspector and the quality control department of that manufacturer failed to do their job. This failure causes unnecessary trouble for other people. If you were doing the inspecting job this failure would not happen. Inspecting is a serious business and one that you as a good craftsman will do to the best of your ability.

Another task package of skills awaits you; go get them, Charlie Brown!

OBJECTIVE:

Upon completion of this task package you will be able to use scales, micrometers, verniers, and jo-blocks to inspect parts. The standard of accuracy will be determined from the part specifications of the drawing.

LEARNING ACTIVITY:

1. View slide-sound program M-II-7.
2. To be able to inspect parts, you must have an increased knowledge of blueprint reading. To gain this knowledge study Units 5 to 11, pages 29 to 55, in Blueprint Reading for Machinists. This is a long assignment, but you have already done harder assignments, and you should have little trouble with this one.
3. In Machine Tool Technology read page 637, the topic Inspectors.
4. Unit 55, pages 434 to 455, in Metalwork Technology and Practice. Note: Quality Control is the name for all inspection practices observed by industry.
5. Some of the information in the above reading assignment you already know or have read about. When you finish your reading look at the topic Coordination and write down the words you know and can explain. Explain the words to another student and see if he agrees with your explanation.
6. Go to your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Necessary measuring devices	3. Good eyesight
2. Surface plate	4. Patience

1. Obtain from your instructor a finished part and a drawing of the part.
2. Using the specifications on the drawing, check the part and determine if you will accept or reject the part.
3. Write down the reason for accepting or rejecting the part. (Be brief and use measurements to back your statements).
4. Take the part, drawing, and your written statement to the instructor for evaluation.
5. Did you convince your instructor you were right in accepting or rejecting the part? If you did, you have been successful in doing a difficult job. Good work! Now put away your tools, clean up the area, and brag a little bit to the other students about how sharp you are.

That's enough bragging; go on to your next task package!

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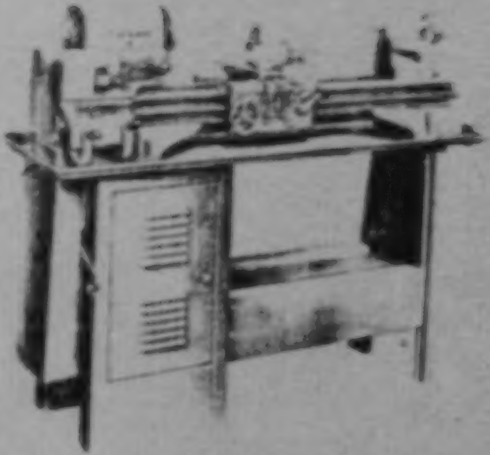

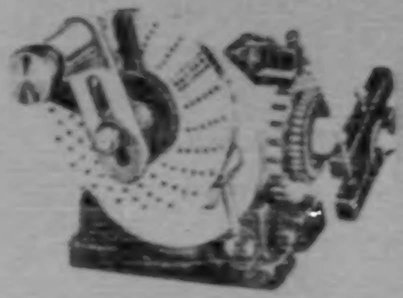

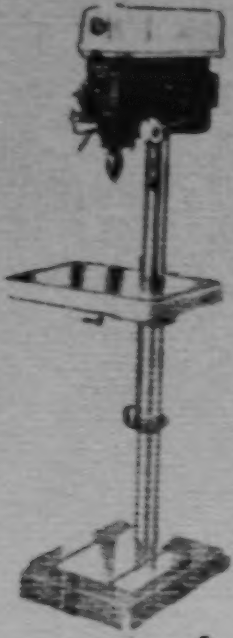

CLUSTER: METALS
COURSE: MACHINE SHOP

CE003793/(e)

UNIT PACKAGE III: POWER SAWS

PREREQUISITES: UNIT I

RATIONALE:

If someone were to ask you to define what a machinist does in two words, you could truthfully answer - cuts stock. The ways in which the machinist cuts stock cannot be so simply summed up in so few words. Instead it takes a machinist his whole working life to learn the various ways to cut stock, and even then he never learns all there is to know.

In this unit you will learn about cutting stock on two different types of bandsaws and you will also cut stock on these saws. The kind of cutting you will be doing will be explained as you read the specific objectives for this unit. Note also, that besides cutting, you will also be given the opportunity to weld the blades that are used on these cutting machines.

OBJECTIVES:

General:

Upon completion of this unit you will be able to cut stock and weld blades, on and for, vertical and horizontal band saws.

Specific:

Upon completion of the task packages for this unit, you will be able to:

OBJECTIVES (cont'd):

1. Use the bulk blade provided and the welding attachment on the vertical band saw to weld band saw blades. Blades will be welded to the length specified for the particular saw by the instructor and to the thickness required by the blade thickness gage on the vertical band saw. Your performance will be evaluated in accordance with the instructor's checklist.
2. Use the horizontal band saw to cut stock. A standard of accuracy of + 1/16th of an inch will be required.
3. Use the horizontal band saw to cut stock to a given angle. A standard of accuracy of ± 1° will be required.
4. Use the vertical band saw to cut contours, circles, and straight lines. A standard of accuracy of + 1/16th of an inch will be the criteria for performance.

LEARNING ACTIVITY:

The task packages in this unit have been designed to be worked in sequence. You will start with the first task package and learn to weld band saw blades and you will also learn about the band saw. In the other task pages in this unit you will be given the chance to make different cuts on these machines. This will be a step by step process that combines learning by studying and learning by doing.

LEARNING ACTIVITY (cont'd):

There may be times, when you are working on these task packages, when you will encounter problems, or it may be that you want some additional information. Feel free to ask the Resource Center Director or your instructor for help or information.

In the packages you will be asked to view a sound-slide presentation, read and answer questions, and perform some practical exercises. The number and names of the task packages included in this unit are as follows.

TASK PACKAGE 1: WELDING BLADES

TASK PACKAGE 2: HORIZONTAL BAND SAW (STRAIGHT CUT)

TASK PACKAGE 3: HORIZONTAL BAND SAW (ANGLE CUT)

TASK PACKAGE 4: VERTICAL BAND SAW

It is possible that you have used metal cutting band saws before. If so, you may feel that you can pass a comprehensive test covering the above material. Your instructor has a test that you can take if you want to. If you don't take the test start with the first task package and learn about power saws.

Enjoy your learning!

UNIT III: POWER SAWS

TASK PACKAGE # 1: WELDING BAND SAW BLADES

PREREQUISITES: NONE

RATIONALE:

In recent years the role of the band saw has increased in the machine shop. Skilled operators are in demand in today's machine industry. One of the skills of the band saw operator is being able to weld the band saw blades together. This is what you will learn in this task package. A good machinist must know how to weld his band saw blades.

Along with the welding of the band saw blades, you will also be introduced to the different types of blades and some of their uses. This is important background information, and in later task packages in this unit you will have a need to refer back to this information. Remember, improper welding techniques will result in continued saw blade breakage and a waste of time.

OBJECTIVE:

Upon completion of this task package you will be able to use the bulk blade provided and the welding attachment on the vertical band saw to weld band saw blades. Blades will be welded to the length specified for the particular saw by the instructor and to the thickness required by the blade thickness gage on the vertical band saw. Your performance will be evaluated in accordance with the instructor's check list.

LEARNING ACTIVITY:

1. View slide-sound program M-III-1.
2. Before you can weld band saw blades you will need a little background information on the blades. In Machine Tool Technology, pages 162 and 163, read the topic Saw Blades and Blade Set.
3. From the above reading answer the following questions:
    a. What are the most widely used blades? _______ _______
    b. The cutting rate with high-speed steel blades may _______ the rate possible with carbon-steel.

NOTE: High-speed steel is a particular alloy of steel. It is not, as the name may imply, a steel that is used only for fast cutting.

LEARNING ACTIVITY (cont'd):

4. Notice Figures 7 and 8, page 162, in this same reference. It shows a band saw blade welder in use. Do not be overly concerned about the sparks that you see, but make sure you always wear safety glasses when welding band saw blades.
5. *Metalwork Technology and Practice*, pages 98 and 99, section 204, tells more about selecting a blade for the band saw. Read this information and then you will be ready to start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. None

1. Your instructor will demonstrate the use of the welder for band saw blades.
2. You will be given several pieces of blade to weld following the demonstration by your instructor.
3. When you have finished welding the blades show your instructor your work.

LEARNING PRACTICE (cont'd):

You may not be given a complete blade to weld at this time, unless it is necessary to make up a blade for one of the machines. However, what you have learned in welding the small pieces will apply when welding a full blade. The length of the blade has nothing to do with how it is welded.

Another new skill has been shown you; there are many more to follow so get on with it by getting your next package.

M-III-2

UNIT III: POWER SAWS

TASK PACKAGE #2: HORIZONTAL BAND SAW

PREREQUISITES: UNIT I; UNIT III, TASK PACKAGE 1

RATIONALE:

Cutting metal stock can be a time consuming chore in the machine shop. If all stock had to be cut with a hand hacksaw the machine age would still be in its infancy. In machine shops today, however, there are power cutoff saws that reduce the labor and time spent in cutting stock to a minimum.

In this task package you will learn to use a horizontal band saw to cut stock to certain lengths. You will see how easy this job is and how you can do it with a fair degree of accuracy. It is most important that you have this knowledge in your "bag of skills" because even the smallest machine shops will have some type of cutoff saw, and you will be required to operate it.

After completing this task package you will probably wonder how you were able to get along without knowing about this work-saving machine.

OBJECTIVE:

Upon completion of this task package you will be able to use the horizontal band saw to cut stock. A standard of accuracy of + 1/16th of an inch will be required.

LEARNING ACTIVITY:

1. View slide-sound programs #M-III-2 and M-III-2A. The slide-sound programs usually show the equipment you will be working on in your school shop. (This is not always true in the reference material you have to read.) Therefore, it may be necessary for you to make some mental adjustments as you approach the equipment you work on. This should not cause you too much confusion, since most machines are made very much alike. You will soon see that, once you have learned to work on one type of machine, you can, after a small period of time, work on other similar machines.
2. Technical Metals, page 93, has an excellent chart, figure 14 - [illegible], showing how to put stock in the vise on the power band saw. Also read page 94, the topic Horizontal Metal-cutting Band Saw. Pay particular attention to the steps used in Cutting Off Stock and refer to figure 14 - 10 when in doubt about the names of the parts of the band saw.
3. Metalwork Technology and Practice, section 199, again on page 94,

LEARNING ACTIVITY (cont'd):

is to be read, and notice figure 179. This shows a simpler horizontal band saw and one that is similar to the one you will be using.

4. Machine Tool Technology, Unit 31, pages 159 and 160, figures 7 - 1 and 7 - 2 show additional types of horizontal band saws. This is the type of equipment you will be using some day, when you are a working machinist.

5. On page 164 of the same reference there is a list of safety rules or precautions. Rules number 3, 4, 5, 6, 8 and 9 apply to the horizontal band saw. Write these rules below:

Rule No.

3.

4.

5.

6.

8.

LEARNING ACTIVITY (cont'd):

Understand what these rules mean. Never take a short-cut at the expense of safety. It is hard to find employment for a man with one arm.

6. Still using the same reference on page 165, Unit 32, read all of Procedure for Square Cutting.
7. You are now ready to start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Horizontal band saw
2. Machinist's scale
3. Scriber
4. Combination square

1. Obtain from your instructor the following materials:
   a. 1 piece of flat stock about 12" in length
   b. 1 piece of roundstock about 12" in length
   c. 1 piece of angle iron about 12" in length
2. From each of the above pieces of stock cut two 1" pieces. Measure and mark each piece before you cut it. Make sure it is in the vise securely. You should have six pieces of stock cut in 1-inch lengths with a + 1/16th of an inch accuracy.
3. Set the stop for making multiple cuts of 1". Cut two pieces from each piece of stock. Is it faster using the stop? Are your pieces more accurate? Yes, should be the answer to both of these questions.

LEARNING PRACTICE (cont'd):

In all machine work there is a lesser or greater degree of skill required. Many machines, such as the horizontal band saw, make your other work less burdensome so you can accomplish your job in a more skillful manner. You have learned a very useful lesson; now improve on this by going on to the next task package. If you can't hack it, don't knock it.

UNIT III: POWER SAWS

TASK PACKAGE #3: HORIZONTAL BANDSAW (ANGLE CUT)

PREREQUISITES: UNIT I; UNIT III, TASK PACKAGES 1 and 2

RATIONALE:

You have seen the importance of being able to use a power bandsaw to cut metal stock. In this task package you will learn to cut stock at an angle. There are many uses for this skill, the chief use being in the construction of objects requiring angular cuts such as tables, workbenches, and other types of equipment.

Learning this skill means you will be adjusting the machine from its normal working position to one that meets the needs of your job. Remember, always return a machine to its normal working position when you are finished with it. Don't leave your mess for someone else to square away. You wouldn't like it.

OBJECTIVE:

Upon completion of this task package you will be able to use the horizontal bandsaw to cut stock to a given angle. A standard of accuracy of ± 1° will be required.

LEARNING ACTIVITY:

1. Review sound-slide programs M-III-2 and M-III-2A again.
2. Machine Tool Technology, page 166, Procedure for Angular Cutting, gives you the necessary information for making angular cuts of metal. Read this very carefully and then go on to your Learning Practice.

   This is a short one!

LEARNING PRACTICE:

Tools and Equipment

1. Horizontal bandsaw
2. Machinist's scale
3. Scriber
4. Combination Square

1. Obtain from your instructor the following materials:
   a. 1 piece of flatstock about 12" in length
   b. 1 piece of roundstock about 12" in length
   c. 2 pieces of angle iron about 12" in length
2. Set the vise at 45° from the blade and cut the flatstock and roundstock at an angle. When the cutting is finished check the degrees of angle. You should be accurate to within ± 1°. If not, reset the vise and try until you successfully make an accurate cut. You will need an accurate setup for the next Learning Practice.
3. It is often necessary, in a machine shop, to construct projects using angle iron. One of the problems encountered is making good joints, at the corners, for welding. One type of corner

LEARNING PRACTICE (cont'd):

joint that is used is called a miter joint. This joint is made by cutting two pieces of angle iron at 45°; then, when they are welded together, a 90° angle is formed. Your problem is to use the two short pieces of angle iron to make a 90° miter joint.

Hint: Use your combination square to draw lines. Don't start off by cutting the pieces. Try to figure this problem out, but if you can not do this then ask your instructor for help.

4. When you have finished show your work to your instructor. Metals is where the action is.

M-III-4

UNIT III: POWER SAWS

TASK PACKAGE #4: VERTICAL BAND SAW

PREREQUISITES: UNIT II, TASK PACKAGE 3; UNIT III, TASK PACKAGE 1

RATIONALE:

In recent years the vertical band saw has won wide acceptance in the machine shop, partly because machinists have seen how useful it can be as a labor saving device and also because the many accessories have made this machine more than just a band saw. You will be introduced to only a few operations on this machine, but in the future, as you continue to work in the machine area, you will spend more and more time working on and learning about the vertical band saw. It is an essential tool for the machinist.

Try this task package. You'll like it!

OBJECTIVE:

Upon completion of this task package you will be able to use the vertical band saw to cut contours, circles, and straight lines. A standard of accuracy of + 1/16th of an inch will be the criteria for performance.

LEARNING ACTIVITY:

1. View slide-sound program M-III-4.
2. Read in Technical Metals, The Vertical Band Saw, pages 94 to 96.
3. Read in Metalwork Technology and Practice, Sections 201, 202, 203, and 204, pages 95 to 100.
4. Read in Machine Tool Technology, Variable-Speed Band Saws, pages 160, 161, and 162. On page 164 are safety precautions. Write the following 1, 2, 6, and 7:

   (1)

   (2)

   (6)

   (7)
5. In the same reference read and study Units 33 and 34, pages 166 to 170.
6. Show your work to your instructor and begin your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Vertical band saw
2. Layout tools
3. Layout fluid
4. Combination square

LEARNING PRACTICE (cont'd):

1. Obtain from your instructor 1 piece of flatstock at least 1/8" thick and 6" square.
2. Lay out a line 1/2" from and parallel to one edge. Make another line 1/2 inch from and parallel to the first line.
3. Lay out a 3" circle in the middle of the stock.
4. Lay out an S-curve on the remainder of the stock.
5. Cut the straight lines, then the S-curve and the circle.
6. Show your work to your instructor.

The vertical band saw can save you time in many applications in the machine shop. When used at the proper speed and with the appropriate blade, there is very little this machine can not do. You are coming along fine. Be proud of the skills you are learning.

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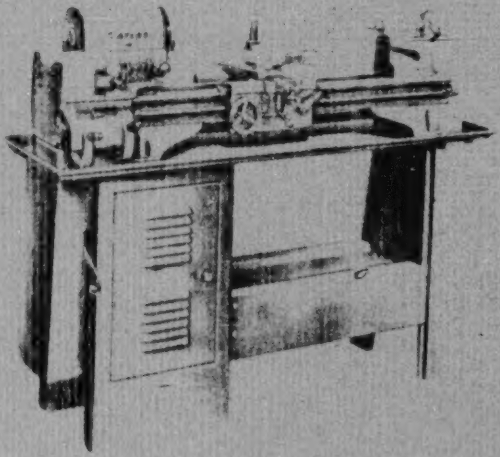

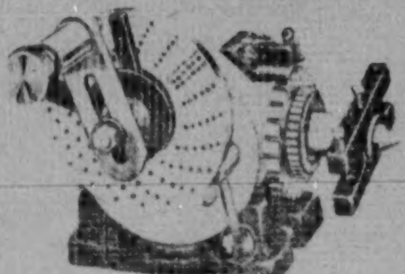

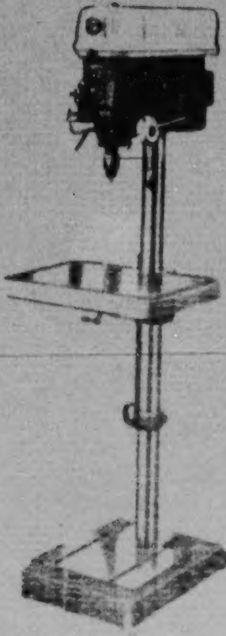

CLUSTER: METALS

COURSE: MACHINE SHOP

cE003931(d)

M-IV

UNIT PACKAGE IV: DRILL PRESS OPERATIONS

PREREQUISITES: UNIT I

RATIONALE:

One of the first machines the new machinist will generally operate is the drill press. The major reason for this is that the drill press can be used to perform many basic operations that will be performed on other machines, thus giving the new machinist good background experience for operating other machines. Another reason is the drill press is not as complicated as a lathe or milling machine to set up and perform cutting operations on.

In this unit you will learn to set up and operate the drill press. Besides the usual operation of drilling holes, you will also do boring, counterboring, spotfacing, and reaming. Many of these operations are meaningless words to you right now, but as you work your way through this unit they will become a permanent part of your vocabulary. Learning can be thrilling when it's about drilling!

OBJECTIVES:

General:

Upon completion of this unit you will be able to operate the drill press in a safe manner while performing drill press operations.

M-IV

UNIT PACKAGE IV: DRILL PRESS OPERATIONS

PREREQUISITES: UNIT I

RATIONALE:

One of the first machines the new machinist will generally operate is the drill press. The major reason for this is that the drill press can be used to perform many basic operations that will be performed on other machines, thus giving the new machinist good background experience for operating other machines. Another reason is the drill press is not as complicated as a lathe or milling machine to set up and perform cutting operations on.

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OBJECTIVES:

General:

Upon completion of this unit you will be able to operate the drill press in a safe manner while performing drill press operations.

OBJECTIVES (cont'd):

Specific:

Upon completion of the task packages for this unit, you will be able to:

1. Use the proper holding devices to engineer set-ups for drilling round-stock, flatstock, sheet metal, and irregular shapes. Acceptable performance will be based on the instructor's checklist.
2. Use sockets, sleeves, and/or chucks to change the holding capacity of a drill press spindle. Your performance will be evaluated using the instructor's checklist.
3. Use the proper speeds and feeds to drill holes in steel, cast iron, brass, and aluminum. A standard of accuracy of ± 1/32nd of an inch will be required and the correct choice of speeds and feeds will be determined by the instructor's checklist.
4. Use the drill press stops, to drill holes to a specified depth. An accuracy of ± 1/16th of an inch will be the acceptable standard of performance.
5. Use the proper tool to countersink, counterbore, and spot face drilled holes. A tolerance of ± 1/32nd of an inch will be an acceptable standard of performance. The correct choice of tool will be determined by the instructor's checklist.

OBJECTIVES (cont'd):

6. Use table adjustments and proper holding devices to drill angular holes in metal. An accuracy of ± 1/32nd of an inch will be the acceptable standard of performance.
7. Use a straight or taper shank reamer to ream holes to a specified size. An accuracy of + 1/64th of an inch will be the acceptable standard of performance.
8. Use correct tap drill size, tap, and tapping attachment to drill and tap holes as shown on drawings. A standard of accuracy of ± 1/32nd of an inch will be the acceptable standard of performance for the depth of the tapped hole.

LEARNING ACTIVITY:

The task packages in this unit have been designed to be worked in a sequence from 1 through 8. The first task package will introduce you to the drill press and drill bits, and each succeeding package will involve you more deeply in the operations of this machine. At the conclusion of the task packages you will be given a test, both written and performance, to check the amount of progress you have made.

In the packages you will be asked to view a sound-slide presentation, read and answer questions, and perform some practical exercises. The number and names of the task packages included in this unit are as follows:

LEARNING ACTIVITY (cont'd):

TASK PACKAGE 1: SETUPS

TASK PACKAGE 2: BIT HOLDING DEVICES

TASK PACKAGE 3: DRILLING HOLES

TASK PACKAGE 4: DEPTH DRILLING

TASK PACKAGE 5: COUNTERSINKING, COUNTERBORING, AND SPOT FACING

TASK PACKAGE 6: ANGULAR HOLES

TASK PACKAGE 7: REAMING

TASK PACKAGE 8: MACHINE TAPPING

After reading the above information, you may feel qualified to pass a comprehensive test covering this unit. If you think you can pass such a test, see your instructor and explain your position to him. If he feels you can do drill press work, your instructor will give you the unit post test. Otherwise, start with task package 1 and learn about the drill press.

UNIT IV: DRILL PRESS OPERATIONS

TASK PACKAGE #1: SETUPS

PREREQUISITES: NONE

RATIONALE:

This task package is your introduction to the drill press. The major point of this task package is using this machine in a safe way, and the only safe way to do drilling is to use holding devices for your workpieces. Only a rank amateur would ever drill a hole on the drill press without clamping down his work. You are no longer an amateur so you will always use clamping devices.

Safety minded pros become old pros!

OBJECTIVE:

Upon completion of this task package you will be able to use the proper holding devices to engineer set-ups for drilling roundstock, flatstock, sheet metal, and irregular shapes. Acceptable performance will be based on the instructor's check list.

LEARNING ACTIVITY:

1. View slide-sound programs M-IV and M-IV-1.
2. Read pages 122 to 127 in Machine Shop Operations and Setups and study the figures showing the different setups.
3. On page 134 in the same reference read and write in the spaces below the following safety rules:

   (1)

   (4)

   (7)

4. In Technical Metals read the topic Workpiece Holding Devices, pages 372 and 373. Study the pictures showing these devices in use.
5. Read Unit 38, pages 177 to 182, in Machine Tool Technology, and Unit 44, pages 203 to 207.
6. Read Unit 28, pages 208 to 213 in Metalwork Technology and Practice. Don't forget to review the new words in the Words to Know section of your text.
7. Advance to the Learning Practice after your instructor has checked your safety rules.

LEARNING PRACTICE:

Tools and Equipment

1. Drill press
2. Holding device

1. Make the following setups on the drill press. (After you have made a setup, have your instructor evaluate your work before making the next setup.)
   - a. For roundstock
   - b. For flat stock
   - c. For sheet metal
   - d. For irregular shapes

NOTE: You may want to make a mark on the piece of stock to show your instructor where the hole would be drilled.

2. After your instructor has evaluated your work, put away the holding devices and clean up your area.
3. Many people make the mistake of drilling holes without using holding devices. The true craftsman does not take a chance with safety!
4. Without precision machinists, man would never have landed on the moon.

M-IV-2

UNIT IV: DRILL PRESS OPERATIONS

TASK PACKAGE #2: BIT HOLDING DEVICES

PREREQUISITES: UNIT IV, TASK PACKAGE 1

RATIONALE:

If your drill bits are not held firmly, you cannot do your work properly. Therefore, bit holding devices are very essential to you as a machinist. So, let's hope this task package holds your attention.

Besides holding the workpiece firmly, you must also know how to insert different drill bits and drill bit holding devices in a drill press. It is with this knowledge that you will be able to get the maximum service from this machine.

In this task package you will be introduced to the drill bit chuck, the sleeve, and the socket and will learn what each of these holding devices can do. You will also use them on a drill press in a number of ways in order to change the capacity of the drill press spindle.

Learn this task package well. You will need this knowledge when you start to drill holes.

OBJECTIVE:

Upon completion of this task package you will be able to use sockets, sleeves, and/or chucks to change the holding capacity of a drill press spindle. Your performance will be evaluated using the instructor's check list.

LEARNING ACTIVITY:

1. View slide-sound program #M-IV-2.
2. Reading assignments:
   a. Technical Metals, pages 370 to 372.
   b. Metalwork Technology and Practice, Unit 25, pages 193 to 199.
   c. Machine Tool Technology, Unit 40, pages 185 to 193.
   d. Machine Shop Operations and Setups, pages 119 to 123.
3. These reading assignments are very important. Read them carefully and feel free to ask your instructor any questions.
4. When you have finished the reading assignments check with your instructor and go into the Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Drill press
2. Chuck
3. Sleeves
4. Sockets

LEARNING PRACTICE (cont'd):

1. Set up the small drill press to accept the following:
   a. 1/2 inch straight shank drill bit
   b. Drill bit with a No. 3 Morse Taper
   c. Drill bit with a No. 2 Morse Taper
   d. Drill bit with a No. 1 Morse Taper
2. Set up the large drill press to accept the above bits and also a No. 4 Morse Taper.
3. When you have completed the above Learning Practice, demonstrate to your instructor that you are able to do this and he will evaluate your performance.
4. Isn't it fun to drill a little bit? Now, remember what you've learned and taper off to the next task package.

UNIT IV: DRILL PRESS OPERATIONS

TASK PACKAGE #3: DRILLING HOLES

PREREQUISITES: UNIT II, TASK PACKAGE 3; UNIT IV, TASK PACKAGE 2

RATIONALE:

Good morning! This is Balloon no. M-IV-3 taking you aloft, so please don't drill any holes in it. Drilling holes is part of the Machinist's craft, but he doesn't puncture balloons - or task packages. He concentrates on metals.

Making round holes in pieces of metal does not sound like much of an accomplishment, but when you have finished this task package you will be ready to disagree with anyone who makes a statement like that.

Besides making a hole, a lot of your time and experience will be used in devising methods of making a hole safely. In fact, it is not unusual when drilling holes to spend much more time clamping the workpiece than in the actual drilling. Remember this when you have a particularly difficult job to clamp and don't take short cuts when safety is involved.

Be sane, be safe, be sound, be around to do another task package!

OBJECTIVE:

Upon completion of this task package you will be able to use the proper speeds and feeds to drill holes in steel, cast iron, brass, and aluminum. A standard of accuracy of ± 1/32nd of an inch will be required and the correct choice of speeds and feeds will be determined by the instructor's check list.

LEARNING ACTIVITY:

1. The show for today is slide-sound program #M-IV-3.
2. Review Mathematics for Vocations, package #13.
3. Read the following assignments:
    a. Machine Tool Technology, Unit 42, pages 199 to 201 and Unit 44, pages 203 to 208. Also notice Table 5, page 187, in the same reference.
    b. Metalwork Technology and Practice, Unit 29, pages 213 to 220.
    c. Machine Shop Operations and Setups, pages 126 to 129. Also on page 134 are Safety Precautions. Write rules number 2, 3, 5, 6, and 8 in the spaces below:

2.

3.

5.

LEARNING ACTIVITY (cont'd):

6.

8.

Do not just write these rules; study, understand, and practice them.

4. Start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Drill press
2. Holding devices
3. Layout tools
4. Selection of drill bits

1. Obtain from your instructor the following stock:
    a. Aluminum
    b. Brass
    c. Cast iron
    d. Steel
2. On each piece of material lay out in some pattern a series of four holes.
    a. Prick, then center punch the holes
    b. Clamp pieces in the drill press
    c. Set the proper speed
    d. Drill holes the following sizes: 3/16, 1/4, 9/16, and 1 inch.

NOTE: In the event the school shop does not have some of the above materials, the correct speed and feed for that material will be presented by you, to the instructor, in written form.

LEARNING PRACTICE (cont'd):

The safety in using the correct holding devices, the use of the proper speeds and feeds, and the striving for accuracy are the important lessons of this task package. If you have learned these items you have done a good job. Keep it up when you go to the next task package.

UNIT IV: DRILL PRESS OPERATIONS

TASK PACKAGE #4: DEPTH DRILLING

PREREQUISITES: UNIT II, TASK PACKAGE #3; UNIT IV, TASK PACKAGE #3

RATIONALE:

The skill to be learned in this task package is not a difficult one, but it is one that takes some practice and you must get to know the machine you are working on. In this task package you will learn how to drill holes using depth stops. The depth stops on each drill press will function just a little bit different and it's these differences you must take into consideration when drilling holes. It is usually a good idea when doing a job to practice on a piece of scrap before doing your workpiece. In this way you learn the machine, and a good craftsman always knows his machines.

Don't rush into this job without knowing what you are doing. You have the time to learn, so take it.

OBJECTIVE:

Upon completion of this task package you will be able to use the drill press stops, to drill holes to a specified depth. An accuracy of ± 1/16th of an inch will be the acceptable standard of performance.

LEARNING ACTIVITY:

1. View slide-sound program M-IV-4.
2. Observe the following figures:
    a. *Machine Tool Technology*, pages 177 and 178, figures 8-1, 8-3, 8-4, and 8-5. Note the different parts of the drill press. In figure 8-1, 8-4, and 8-5, the depth stop is not labeled, but it is clearly visible. In figure 8-3, the depth stop is labeled. Also notice the depth scale and pointer on these drill presses.
    b. *Machine Shop Operations and Setups*, page 89, figure 1, shows another type of drill press with a different kind of depth gage and depth stop.
3. You will find some difference in the types of depth stops on different drill presses. Most of them work by using two nut-like devices that are locked in place by tightening one against the other. This locking method is

LEARNING ACTIVITY (cont'd):

called double nutting, and is often used in a machine shop for removing or inserting studs.

4. There are two different depths in a drilled hole. On page 85, Blueprint Reading for Machinists, at the top of the page, the left and center illustrations show how a blind drilled hole would look. The depth made by the point of the drill bit is somewhat deeper than the hole made by the body of the drill bit. Normally the depth of a drilled hole, when given on a drawing, will be the depth shown in the center illustration on page 85 - that is, the body depth. You, as a machinist, must be aware of the different depths since there are times when a drawing may be wrong, and if you were to follow the dimensions of the drawing, the point of the drill would come through the workpiece and the workpiece would become scrap.
5. There is very little information on drilling to a certain depth in your reference material. This is one of those skills that must be learned by practice. So go on to your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Drill press
2. Layout tools

LEARNING PRACTICE (cont'd):

3. Depth micrometer
4. Prick and center punches

1. Obtain from your instructor a piece of flat stock at least 7/8" or 1" thick.
2. Lay out a series of at least 10 holes. You may do more if you think you need the practice.
3. Drill holes to the following depths:

   a. 1/4" b. 5/16" c. 3/8" d. 7/16" e. 1/2"
   f. 9/16" g. 5/8" h. 11/16" i. 3/4" j. .427

   NOTE: Use at least a 3/8" drill bit and all depths are for body size.
4. Label the holes and write down the depth you have drilled. Show the work to your instructor. Keep this piece of stock for your next task package.
5. Beethoven was a perfectionist. Why shouldn't you become one, too?

M-IV-5

UNIT IV: DRILL PRESS OPERATIONS

TASK PACKAGE #5: COUNTERSINKING, COUNTER BORING, AND SPOT FACING

PREREQUISITES: UNIT IV, TASK PACKAGE #4

RATIONALE:

Spaceship M-IV-5 is now on the launch pad. It's countdown time for countersinking, counter boring and spot facing. Ready? 5, 4, 3, 2, 1 - blast off into this task package.

The three operations that you will learn in this task package are performed on machines other than a drill press, but most of the time the drill press will be used to do them. All three of these operations, countersinking, counter boring, and spot facing, serve very serious purposes in the machine trades.

One of the many uses of countersinking is on high speed aircraft and spaceships. Countersinking helps to decrease wind resistance of these vehicles by keeping the heads of the fastener even with the surface.

Counter boring and spot facing are used on many parts and castings. After you have finished this task package take a look around the machine shop and see how many pieces of equipment have had these operations performed on them.

To be a good machinist you must know these operations. If this is your goal, this task package is waiting to help you.

OBJECTIVE:

Upon completion of this task package you will be able to use the proper tool to countersink, counter bore, and spot face drilled holes. A tolerance of ± 1/32nd of an inch will be an acceptable standard of performance. The correct choice of tool will be determined by the instructor's check list.

LEARNING ACTIVITY:

1. View slide-sound program # M-IV-5 for today's show.
2. Study Unit 14, page 69, in Blueprint Reading for Machinists and Unit 19, page 89.
    a. Technical Metals, pages 377 and 378, the topics Countersinking, Counter Boring, Spot Facing. Note figures 79-41, 79-42, 79-43, and 79-44.
    b. Machine Tool Technology, pages 192 and 193, the topics Counter Boring Tools and Countersinks.
    c. Machine Shop Operations and Setups, pages 111 and 112.
    d. Metalwork Technology and Practice, pages 224 and 225, sections 587 to 594.
4. A common element in the three operations you have been reading about is that the depth of the operations must be controlled.

LEARNING ACTIVITY (cont'd):

The ± 1/32nd of an inch is a fair degree of accuracy for beginners, but after you have mastered these operations you will have to work to the .001 of an inch.

5. Go to your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Drill press
2. Counter bores, spot facers, and countersinks
3. Holding devices

1. Using the piece of stock from your last task package, drill 5 more holes in it with a 3/16" drill bit. (You should now have 15 holes in this piece.)
2. Counter bore 5 holes to a depth of 3/8". (You may have to drill some of these holes deeper.)
3. Spot face 5 holes.
4. Countersink the five 3/16" diameter holes. (You will need a 3/16" flat head screw to check the depth of the countersink.) See Metalwork Technology and Practice, figure 462, page 224.
5. When you have completed the fifteen holes, show your work to your instructor.

LEARNING PRACTICE (cont'd):

6. You can count on countersinking and counter boring - along with spot facing - to aid you in the machinist's craft.

You might want to show your friends what a good job you did on this task package and explain why these different operations are used. When you have finished your bragging (a good craftsman always brags a little), try another task package.

M-IV-6

UNIT IV: DRILL PRESS OPERATIONS

TASK PACKAGE #6: ANGULAR HOLES

PREREQUISITES: UNIT IV, TASK PACKAGE #5

RATIONALE:

There are many "angles" to the machinist's trade and one of them is drilling angular holes. In this task package, using some of the skills which you have learned previously, you will drill angular holes in a workpiece. Combining different skills to solve problems is one of the outstanding traits of the machinist. Because of this ability, many people think of the machinist as a "jack-of-all-trades" when in reality he is just a man that can "get it all together" when a problem has to be solved. If this is the type of person you are or would like to be, then the machinist's trade is the trade for you.

Your task package awaits you, Sire!

OBJECTIVE:

Upon completion of this task package you will be able to use table adjustments and proper holding devices to drill angular holes in metal. An accuracy of ± 1/32nd of an inch will be the acceptable standard of performance.

LEARNING ACTIVITY:

1. View slide-sound program #M-IV-6.
2. *Machine Tool Technology*, page 178, figure 8-3, shows the parts of the drill press. Notice the index pin, tilt angle scale, and the tilting table. Not shown is a nut that is used to lock and unlock the table.

   To use the table for doing angular drilling the following steps should be employed:

   a. Remove the index pin.
   b. Loosen the table locking nut.
   c. Tilt table to the number of degrees desired.
   d. Tighten the table locking nut.
   e. Replace index pin if possible.

NOTE; You may get the number of degrees of tilt by using the tilt angle scale, but a more accurate method is to use the bevel protractor head of the combination square set. Place the

LEARNING ACTIVITY (cont'd):

protractor head on the table and line up the blade with the spindle. Another method that can be employed, if the drill press is level, is to use the spirit level in the protractor head. Set the protractor for the desired degrees, place it on the table and tilt the table until the bubble is between the level marks. This method can only be used if the drill press is level in all directions. Check the drill press before using this method.

3. Another method used to drill angular holes on the drill press is to use blocks under one side of the workpiece. This is somewhat harder to do than tilting the table and it requires some difficult clamping procedures, but it can be used if the table does not tilt.
4. There is no information in your reference material on drilling angular holes.
5. Start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Drill press with tilting table
2. Drill bit - 3/8"
3. Layout tools
4. Combination square set
5. Prick and center punches

LEARNING PRACTICE (cont'd:

1. Obtain a block of metal from your instructor.
2. Lay out and drill two 45° angular holes, one on each side. Try to make these holes meet in the middle of the block.
3. Show your work to the instructor.

The job that you did in this task package is a very basic type of operation on the drill press. There are more interesting ones waiting for you in the next task packages. So, what are you waiting for?

UNIT IV: DRILL PRESS OPERATIONS

TASK PACKAGE #7: REAMING

PREREQUISITES: UNIT IV, TASK PACKAGE 6

RATIONALE:

Have you ever heard anyone say he had to ream the king-pin bushings on a car? If you have, it is likely you didn't really know what he was talking about. When you finish this task package you will know what is meant by reaming, and what's more, you will be able to do it. As for the king-pin bushings, that information you will find out from study of automotive mechanics.

Reaming is used in places other than automobiles. As a machinist it is a skill you will be called on to perform many times. So learn the lessons of this task package well, and it will help to enhance your role as a machinist.

Ream your way through this task package!

OBJECTIVE:

Upon completion of this task package you will be able to use a straight or taper shank reamer to ream holes to a specified size. An accuracy of + 1/64th of an inch will be the acceptable standard of performance.

LEARNING ACTIVITY:

1. The feature for today is sound-slide program M-IV-7.

2. In your reading material, read the following assignments:

   a. Technical Metals, page 377, topics, Reaming and Using a Machine Reamer.

   b. Machine Shop Operations and Setups, pages 113 to 120, and pages 131 and 132.

   c. Metalwork Technology and Practice, pages 220 to 225.

   d. Machine Tool Technology, Unit 41, page 193 and Unit 46, page 209.

3. Answer the following questions:

   a. The hole to be reamed should be from __________ to _______________ of an inch undersize.

   b. You should never turn a reamer _______________ even when taking it out of the hole.

   c. List the four types of chucking reamers:

      (1)

      (2)

      (3)

      (4)

LEARNING ACTIVITY (cont'd):

d. List the five types of hand reamers:

(1)

(2)

(3)

(4)

(5)

4. You should now have an idea of what reamers are and what they are used for. It's time to put them to work. Start your Learning Practice after your instructor has seen your work.

LEARNING PRACTICE:

Tools and Equipment

1. Drill press
2. Chucking reamers
3. Hand reamers

1. Obtain from your instructor a piece of thick stock and drill two undersize holes in it.
2. Using the drill press spindle as a guide and a hand reamer, ream the two holes to size by hand.

LEARNING PRACTICE: (cont'd):

3. Drill four more undersize holes and ream these to size, using machine reamers.
4. Have your instructor evaluate your work.

You have completed another task package.

Remember that the reamer is used for making very accurate holes. Something else to think about when speaking of accurate holes is that, if you ream a hole to 1/4" in diameter, you can not put a 1/4" diameter rod in it without forcing the rod in the hole. Try it and see.

Do you understand why this is so?

M-IV-8

UNIT IV: DRILL PRESS OPERATIONS

TASK PACKAGE #8: MACHINE TAPPING

PREREQUISITES: UNIT IV, TASK PACKAGE #7

RATIONALE:

This is secret agent M-IV-8 tapping you on the shoulder. What secrets have you uncovered about machine tapping? None? Then break the code on this task package.

You have seen and used many of the drill press operations and you should have found them to be helpful in obtaining your goal as a craftsman and a machinist. In this task package, you will learn another operation that will not only increase the accuracy with which you can tap holes, but will also make the job much easier than doing it by hand. If this is so, you might be asking yourself, why did I have to learn hand tapping? The reason you learned hand tapping is because it is extremely hard to drag a drill press under a car and set it up and tap a hole in a crankcase. If you don't believe this, try it!

The lesson to be learned from this is that there is a place for each operation you have learned. Your job as a skilled craftsman is to do the correct operation in the correct place.

OBJECTIVE:

Upon completion of this task package you will be able to use correct tap drill size, tap, and tapping attachment to drill and tap holes as shown on drawings. A standard of accuracy of ± 1/32nd of an inch will be the acceptable standard of performance for the depth of the tapped hole.

LEARNING ACTIVITY:

1. Today's secret show is slide-sound program # M-IV-8.
2. Reading assignments:
   - a. Metalwork Technology and Practice, pages 225 and 226, sections 594, 595, and 596.

NOTE: Figure 466, page 226 shows a method of starting a tap using the drill press. With this method you just start the tap using hand power. Do not turn the machine on.

   - b. Machine Tool Technology, page 180, figure 8-8 shows another type of tapping attachment used on the drill press.

3. It is important that you understand tap drill size and where you can obtain this information. For the following reference materials write down the pages you will find this on. Big hint: Use the index.

LEARNING ACTIVITY (cont'd):

Reference Source	Page Number
a. Metalwork Technology and Practice	
b. Machine Tool Technology	
c. Technical Metals	
d. Machine Shop Operations and Setups	

4. You may have trouble understanding how to use some of these tables. If so, show them to your instructor and he can help you.

5. You are now ready for your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Drill press
2. Tapping attachment
3. Tap size drill bits
4. Taps

1. From your instructor obtain a piece of metal about 1/2" thick.
2. Drill 6 holes for the following size threads:

   a. 10-24 UNC
   b. 10-32 UNF
   c. 5/16-18 UNC
   d. 5/16-24 UNF
   e. 7/16-14 UNC
   f. 7/16-20 UNF

3. Have your instructor observe you as you make the setup and tap the above holes.

4. When you have completed the tapping of the six holes, insert bolts or screws in them and show the work to your instructor. You have completed another task package. Put away your tools and clean up the area. Clean up today for higher pay!

RESEARCH PROJECT
SANFORD CENTRAL HIGH SCHOOL
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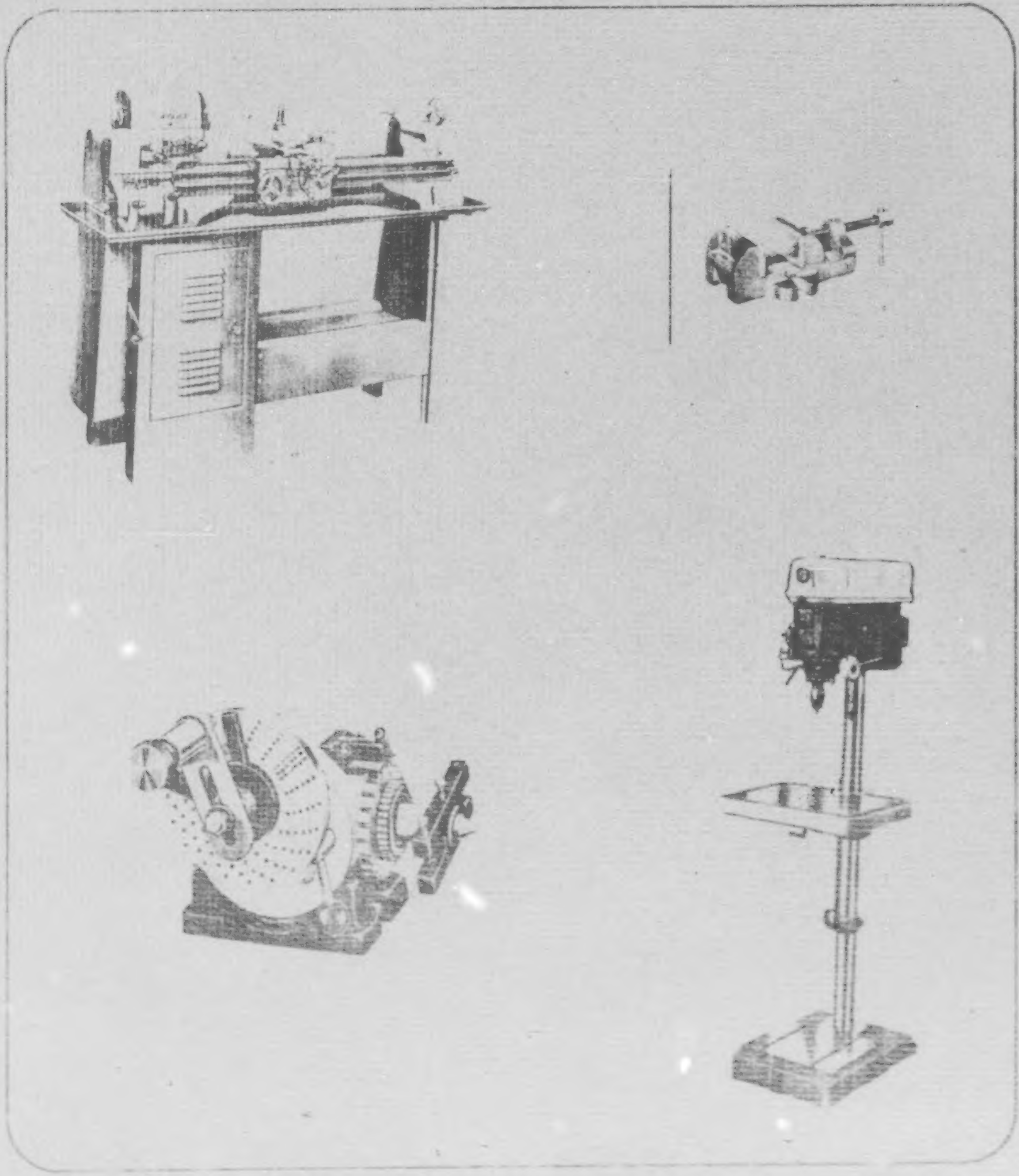


CLUSTER: METALS

COURSE: MACHINE SHOP

CE003931(e)

M-V

UNIT PACKAGE V: HAND AND DRILL BIT GRINDERS

PREREQUISITES: UNIT I

RATIONALE:

This unit is concerned with two types of grinding machines: one that you will find in all machine shops and one that will be found in most machine shops. The one that is used in all machine shops is the hand grinder--so called, because the workpiece is held in the machinist's hand when he is grinding on this machine. The hand grinders are also known as pedestal and bench grinders, depending on how and where they are mounted.

The grinder that you will find in most machine shops is the drill bit grinder. As the name implies, it is used to grind or sharpen drill bits. This machine is a real work saver and also a money saver.

You will also learn, in this unit, about grinding wheels and how to true and shape them. This should be an enjoyable unit and one in which you will learn many new things.

OBJECTIVES:

General:

Upon completion of this unit you will be able to use hand and drill bit grinders for grinding metal and sharpening drill bits.

OBJECTIVES (cont'd):

Specific:

Upon completion of the task packages for this unit, you will be able to:

1. Use the reference chart in Metalwork Technology and Practice, page 400, figure 849, to correctly select grinding wheels and install and adjust the wheels and tool rest. Acceptable performance will be based on the instructor's checklist.
2. Use a Huntington wheel dresser to dress a grinding wheel for normal grinding and orally state how and why you shape a wheel. Your performance will be evaluated in accordance with the instructor's checklist.
3. Use the drill bit grinder to sharpen drill bits. The standard of acceptable performance is a tolerance of ± 1° included angle.

LEARNING ACTIVITY:

The three packages of this unit have been designed to be worked in sequence. Starting with grinding wheels you will proceed to the drill bit grinder.

If, while doing this unit you have a problem, see the Resource Center Director or your instructor for help.

In the packages you will be asked to view a sound-slide presentation, read and answer questions, and perform some practical exercises. The number and names of the task packages included in this unit are as follows:

LEARNING ACTIVITY (cont'd):

TASK PACKAGE 1: GRINDING WHEELS

TASK PACKAGE 2: DRESSING WHEELS

TASK PACKAGE 3: DRILL BIT GRINDER

A comprehensive test will be given to you if you feel, at this point, that you are qualified to take it. However, if you have had no experience in this area, start with the first task package and learn about grinding.

M-V-1

UNIT 5: HAND AND DRILL BIT GRINDERS

TASK PACKAGE 1: GRINDING WHEELS

PREREQUISITE: UNIT I

RATIONALE:

Don't grind to a stop at this point, but don't become a regular grind in your studies, either. Just learn the grinding techniques in this task package and you'll become a wheel as a machinist.

Grinding metal by hand is one of those skills that takes many years to develop. Learning to select the proper wheels to use on the grinding machine requires less time to learn, but this selecting does require the machinist to be able to use and understand his reference material. The good machinist is one who is studying and learning all the time. He is a person who lets his brain do a lot of his work. The man with a strong back and a weak mind does not become a machinist. Since you are not this type of person and you are going to be a machinist, you must be able to work with your books as well as with your machines.

Remember: Your books are your tools - use them as such!

OBJECTIVE:

Upon completion of this task package you will be able to use the reference chart in Metalwork Technology and Practice, page 400, figure 849, to correctly select grinding wheels and install and adjust the wheels and tool rest. Acceptable performance will be based on the instructor's check list.

LEARNING ACTIVITY:

1. The feature attraction for today is slide-sound program #M-V-1.
2. Reference material for you to read.
   a. Machine Tool Technology, Unit 111, pages 410 to 421.
   b. Machine Shop Operations and Setups, pages 393 to 398.
   c. Metalwork Technology and Practice, Unit 49, pages 397 to 402, and Unit 50, pages 403 to 410.
   d. Technical Metals, pages 384 and 385.
3. In reference b. above on page 397, there are some safety precautions. In the space below write rules number 5, 7, 8, and 10.

(5)

(7)

(8)

LEARNING ACTIVITY (cont'd):

(10)

4. Study the rules in reference d. on page 385.
5. In reference c. note figures 857 and 858. After installing a new grinding wheel, the tool rest should be moved toward the wheel. The gap between the wheel and the tool rest should never be more than 1/8th of an inch.
6. Never use wood, plastic, brass, aluminum, copper, or other soft materials on a grinding wheel. These materials cause the wheel to become clogged and a clogged wheel will overheat.
7. When you have written your safety rules, show them to your instructor and start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Hand grinder
2. Necessary tools

1. Select two grinding wheels, one for grinding soft steel and one for grinding hard steel. Have your instructor evaluate your choice.
2. Remove and replace the grinding wheels on a grinder and have your instructor inspect your work.
3. Adjust the tool rest.
4. When the grinder is ready, have your instructor inspect your work.

LEARNING PRACTICE (cont'd):

5. This completes this task package. Note the emphasis on safety in this package. The grinder can be a dangerous machine if not used properly.

   Without machinists, we would still be riding horses instead of cars.

UNIT V: HAND AND DRILL BIT GRINDERS

TASK PACKAGE #2: DRESSING WHEELS

PREREQUISITE: UNIT V, TASK PACKAGE 1

RATIONALE:

You dress yourself every morning, don't you? Did you ever dress a wheel? Are you dressing a wheel when you dress yourself? All right, how would you like to learn about dressing another wheel?

Although the hand grinder requires a high degree of hand skill, you as a machinist can get some help in doing skillful work by using shaped grinding wheels. Another help in doing good grinding is truing or dressing the grinding wheel.

In this task package you will be asked to dress a grinding wheel for normal grinding, but because of the cost involved you will not be able to shape a wheel. You will, however, learn about shaping and why and how it is done. There may come a time when the instructor will need a shaped wheel, so be ready to do this job if the opportunity comes along.

You won't find this task package a grind!

OBJECTIVE:

Upon completion of this task package you will be able to use a Huntington wheel dresser to dress a grinding wheel for normal grinding and orally state how and why you shape a wheel. Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View slide-sound program M-V-2 as today's feature.
2. Technical Metals, page 385, figure 30-25 is an excellent picture of a Huntington wheel dresser.
3, Metalwork Technology and Practice, unit 51, pages 410 to 418 shows the use of the wheel dresser and also some related information on grinding. Also on page 416 are some Words to Know. Keep adding words to your machinist's vocabulary.
4. Machine Tool Technology, Unit 110, pages 407 to 411, has some information on abrasive properties.
5. In your previous task package reading assignment, the shapes of the grinding wheels were discussed. List below the name used to describe the wheel and a use for it.

Wheel Type	Name	Use
a. Type 1		
b. Type 1		
c. Type 2		

LEARNING ACTIVITY (cont'd):

Wheel Type	Name	Use
d. Type 5		
e. Type 6		
f. Type 6		
g. Type 11		
h. Type 11		
i. Type 12		
j. Type 13		
k. Type 20		
l. Type 21		

6. Draw the faces of shaped wheels below. Do not make them up. Find the shape in your reference material.

a.

b.

c.

d.

e.

f.

g.

h.

i.

j.

7. Now that you know something about the wheels, it's time to finish up the safety rules on page 397 in Machine Shop Operations and Setups. Do rules number 1, 2, 3, 4, 6, and 9.

(1)

(2)

LEARNING ACTIVITY (con't):

(3)

(4)

(5)

(6)

8. You are now ready to start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Grinding machine 2. Wheel dresser

1. Have the instructor assign you a grinding wheel to dress.
2. Dress this wheel for normal grinding.
3. Scribe a line on a piece of steel, about 1/16th of an inch from the edge, and using all safety precautions, grind the stock down to the line.
4. Redress the wheel and show your instructor your work.

NOTE: Always check the gap between the tool rest and the wheel. When the gap is more than 1/8" readjust the tool rest. The number of jobs that can be done on the grinder is limited by the mechanic who is using the grinder. Happiness is a job well done.

UNIT V: HAND AND DRILL BIT GRINDERS

TASK PACKAGE #3: DRILL BIT GRINDER

PREREQUISITE: UNIT V, TASK PACKAGE 2

RATIONALE:

Are you a sharp fellow? It's good to be a little sharp, you know. Sharp fellows make sharp machinists, and sharp machinists know how to sharpen their tools.

Of the many tasks that are performed in the machine shop, sharpening drill bits is the one that is performed most often. It is one of those basic jobs that you, as a machinist, will be expected to do.

There are two techniques for sharpening drill bits. One is by hand; that is, holding the drill bit in your hand and against a grinding wheel. The other technique is to use a drill bit grinding machine, and this is what you are going to learn in this task package. With the aid of the drill bit grinding machine, you, as a new machinist, can grind bits as fast or faster, and every bit as accurately as a professional machinist.

Think you would like to try this? Then move into this task package!

OBJECTIVE:

Upon completion of this task package you will be able to use the drill bit grinder to sharpen drill bits. The standard of acceptable performance is a tolerance of ±1° included angle.

LEARNING ACTIVITY:

1. View slide-sound program #M-V-3 and enjoy the show.
2. Read the following reference material:
   a. Machine Tool Technology, Unit 43, pages 201 to 203.
      Note the drill grinding attachment, figure B-54, page 202.
   b. Metalwork Technology and Practice, Unit 26, pages 199 to 203.
   c. Technical Metals, pages 374 to 376.
   d. Machine Shop Operations and Setups, pages 106 to 112.
3. The information in your reference material is of a general nature that applies to both machine and hand grinding of drill bits. You should, when you have the opportunity, learn to grind drill bits by hand. It takes skill, a steady hand, and a large amount of practice to do, but many employers still use this as one method of judging the competence of a machinist.
4. Figure 1 of this task package shows the drill bit grinder that you will use in the machine shop.

LEARNING ACTIVITY (cont'd):

5. Figure 2 of this task package shows the steps used in operating this machine. Go to the machine shop and, as you read these instructions, locate the parts and go through the motions of grinding a drill bit.
6. You are ready for your Learning Practice.

LEARNING PRACTICE:

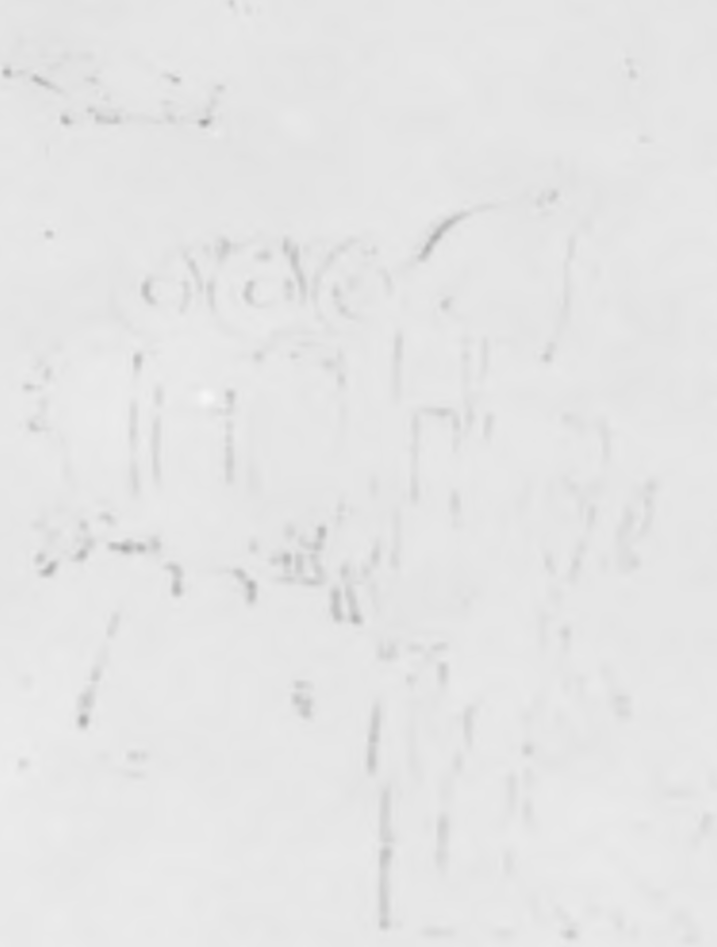
Tools and Equipment

1. Drill bit grinding machine
2. Drill grinding gage
3. Drill bits

1. Obtain from your instructor six drill bits that need grinding.
2. Set up the first drill bit to be ground and have your instructor evaluate your setup.
3. Grind the drill bits. Check each one after it has been ground.
4. Have your instructor check your work.

Another lesson well learned. As you can see your skills are multiplying, maybe much faster than you thought they would when you first started on your task packages. Keep up the good work.

5. Be sharp, look sharp, feel sharp!



The [illegible] Black Diamond Drill Grinder is available in 5 models, covering various ranges of drill sizes from 1/8 to 3/4" (see specifications chart). Drills are accurately centered and locked in correct position for precision grinding. Lips are always ground to identical length and at precisely the correct angle. Both lips are ground in one operation. Clearance is ground for high speed cutting, with maximum support behind cutting edge. [illegible] is held at an absolute minimum, to [illegible] [illegible] drill life. A precision web thinning attachment is available (see [illegible] page). The diamond dresser keeps the wheel face dressed smoothly.

A [illegible] feature is the optional set of clearance cams, providing a quick, simple change of clearance angle. The Regular model is supplied with a cam for normal 12° clearance. Two supplementary cams are also available, providing additional clearances of approx. 16° and approx. 7° as desired.

FIGURE 3

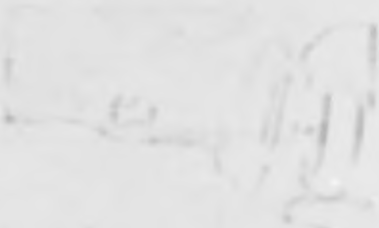
4 QUICK, EASY STEPS

to FASTER, MORE ACCURATE DRILL GRINDING!

1 [illegible]

[illegible] drill [illegible] and [illegible] drill holder. Tighten the [illegible] [illegible].

[illegible]



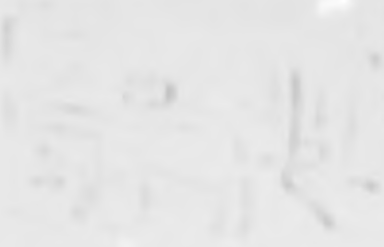
2 LOCATE

Push drill holder into proper locator until point of drill rests in locator bit.

This simple action positions the drill automatically so that only the correct amount of [illegible] is removed during grinding.

The four quick steps shown [illegible] in a constant supply of accurately ground drills that will maintain maximum uniformity of hole, vastly reduce drill breakage and prolong drill life. Yet the operation of a Black Diamond Drill Grinder is so simple that any inexperienced worker can learn it in a few minutes!

"Positive positioning" is the reason. The drills are automatically positioned to the exact angle required. No guesswork, no optical [illegible], no time-consuming adjustments. The entire operation has been carefully pre-designed for maximum accuracy with minimum labor.



3 [illegible]

[illegible] drill holder to [illegible] position [illegible] drill [illegible].

[illegible]

4 GRIND

Insert drill holder in [illegible], and grind drill by simply [illegible] both lips are ground.

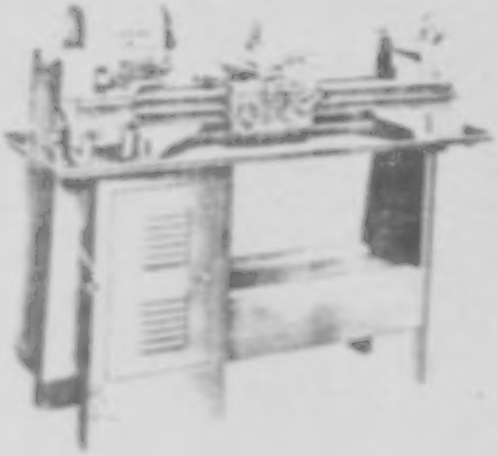
Both lips are ground to the same [illegible]. The amount of [illegible] removed [illegible].

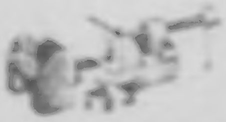
[illegible] Black Diamonds are built for long, [illegible] shop [illegible] [illegible] are [illegible] [illegible] throughout the U. S. in automotive, aircraft, [illegible] and [illegible] plants have relied for years on their economical, foolproof Black Diamond Drill Grinders.

Figure 3

182

RESEARCH PROJECT
SANFORD CENTRAL HIGH SCHOOL
1708 NASH STREET
SANFORD, NORTH CAROLINA 27330





[illegible]

[illegible]

M-VI

UNIT PACKAGE VI: THE ENGINE LATHE

PREREQUISITES: UNIT I

RATIONALE:

In this unit you will study and work with what can be considered the basic machine in the machine shop, the engine lathe. When first developed, the lathe was used to make round pieces; now, however, the lathe has become an extremely versatile machine that will do many more operations than just making round pieces.

You will get some idea of the versatility of this machine as you read through the Specific Objectives for this unit, and are introduced to the tasks that you will be asked to do in the fourteen task packages listed in the Learning Activity.

The fourteen task packages cover most, but not all, of the basic lathe operations. The other operations you will learn as you work in the machine shop and develop into a first-class machinist.

OBJECTIVES:

General:

Upon completion of this unit you will be able to use the engine lathe to perform various metal cutting operations.

OBJECTIVES (cont'd):

Specific:

Upon completion of the task packages for this unit, you will be able to:

1. Use the thread cleaner, cradle or cleat board, chuck wrench, and other necessary tools to clean and mount 3-jaw chucks. Acceptable performance will be based on the instructor's checklist.
2. Use a 3-jaw chuck and appropriate tools to perform facing, turning, parting (cut off), chamfering, and square and filleted shoulders. The standard of accuracy will be determined by the specifications of the drawing of the part.
3. Use centers for alignment and necessary holding devices to adjust the tailstock to the zero position and prepare it for drilling operations. The standard of acceptance, for checking the position of the tailstock, will be turning a six-inch piece of stock with a tolerance of ± .001 of an inch from end to end.
4. Use a dial indicator for truing the workpiece for performing appropriate lathe operations in a 4-jaw chuck. The standard of acceptance will be determined by the specifications of the drawing.
5. Use the correct collet assembly to perform appropriate lathe operations in a collet assembly. The standard of acceptance will be determined by the specifications of the drawing and your setup will be evaluated in accordance with the instructor's checklist.

OBJECTIVES (cont'd):

6. Use a face plate, centers, and lathe dog to perform appropriate lathe operations between centers. The standard of accuracy will be determined by the specifications of the drawing, and your setup will be evaluated in accordance with the instructor's checklist.

7. Use a steady rest to turn a long shaft. The standard of accuracy will be determined by the specifications of the drawing. Your performance will be evaluated in accordance with the instructor's checklist.

8. Use a follower rest to turn a long, thin shaft. The standard of accuracy will be determined by the specifications of the drawing. Your performance will be evaluated in accordance with the instructor's checklist.

9. Do the following:
   a. select and use the correct drill bit for drilling an undersize hole for a given reamer.
   b. ream to a given size.

   Performance requirements involve an accuracy of ± 1/64 of an inch.

10. Use the mandrel between centers to perform appropriate lathe operations on a workpiece mounted on a mandrel. The standard of acceptance will be determined by the specifications of the drawing.

11. Use a boring bar assembly to increase the size of a hole, to a given size. Acceptable performance will be a tolerance of ± .001 of an inch.

OBJECTIVES (cont'd):

12. Use hand ground and formed thread cutting tools, and dies and diestock to thread right and left-hand threads. The standard of accuracy will be determined by the specifications of the drawing.

13. Use the compound, offset tailstock, and taper attachment to turn tapers to a specific degree of inches of taper per foot. The standard of accuracy will be determined by the specifications of the drawing.

14. Use files, abrasive cloth, and lapping compound to surface finish stock. Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

The task packages in this unit have been designed to be worked in sequence. You will start with an introduction to the lathe and install chucks in the first task package, and proceed step by step, through the lathe operations until the final task package, in which you will learn how to polish your workpiece and give it a professional look.

Along the way, you will be asked to check with your instructor and show him your work. You may also, at any time, ask him if you have a problem or you may also make inquiries of the Resource Center Director, who will also be able to help you.

LEARNING ACTIVITY (cont'd):

In the packages you will be asked to view a sound-slide presentation, read and answer questions and perform some practical exercises. The number and names of the task packages included in this unit are as follows:

TASK PACKAGE 1: INSTALLING CHUCKS
TASK PACKAGE 2: 3-JAW OPERATIONS
TASK PACKAGE 3: TAILSTOCK ADJUSTMENT
TASK PACKAGE 4: 4-JAW OPERATIONS
TASK PACKAGE 5: COLLET ASSEMBLY
TASK PACKAGE 6: FACE PLATE
TASK PACKAGE 7: STEADY REST
TASK PACKAGE 8: DRILL AND REAM
TASK PACKAGE 10: MANDREL
TASK PACKAGE 11: BORING
TASK PACKAGE 12: THREADING
TASK PACKAGE 13: TAPERS
TASK PACKAGE 14: KNURLING
TASK PACKAGE 20: TURRET LATHE
TASK PACKAGE 21: TRACER LATHE

If you have had lathe experience and feel you can accomplish all of the Specific Objectives of this unit, you may want to take a comprehensive test covering lathe work. Your instructor has a test that you can take if he feels that you are ready for it. However, if you do not feel qualified to take the test, start working on task package one in this unit.

[illegible]

UNIT VII: THE ENGINE LATHE

[illegible]

[illegible]

[illegible]

[illegible] Should you like to [illegible]? This here is a very interesting [illegible].

This unit package will introduce you to the oldest and most basic machine in the machine shop, the lathe. Besides being the oldest machine, the screw cutting engine lathe (its full name) is considered to be the most important of the machine tools. From the lathe all other machine tools have been developed. The industrial progress we have seen in the United States would not have been possible without a good machine industry, and the lathe is the foundation of that industry.

Along with your introduction to the lathe you will also, at this time, learn to identify the parts of the machine and also how to assemble the lathe for turning a work piece. This is an important lesson, so learn it well.

[illegible]

OBJECTIVES

> Upon completion of this task package you will be able to use the thread cleaner, cradle or chuck board, chuck wrench, and other necessary tools to clean and mount 3 - jaw chucks. Acceptable performance will be based on the instructor's check list.

LEARNING ACTIVITY

1. The triple feature for today is slide-sound programs FS-VI, M-II-1, and M-II-1I.
2. Reference Readings:
   a. Technical Metals, Unit 73, pages 342 and 343.
   b. Machine Shop Operations and Setups, pages 135 to 141. Examine closely the transmission of the lathe between pages 134 and 135.
   c. Metalwork Technology and Practice, Unit 37, pages 462 to 475.
   d. Machine Tool Technology, Unit 31, pages 217 to 221, and Unit 35, pages 250 to 255.
3. The transmission in Machine Shop Operations and Setups and some of the reading assignments set up introduction and background to the lathe.

LEARNING ACTIVITY (cont'd):

4. Note carefully the procedures for mounting and removing the chuck in Machine Tool Technology.

5. The points that need to be emphasized are:
   a. The spindle nose and the threads in the chuck must be clean.
   b. The use of a cradle or cleated board is for your safety and the protection of the machine.

6. You should now be ready to go to your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Lathe
2. 3 - jaw chuck
3. Chuck wrench
4. Cradle or cleated board
5. Thread cleaner

1. Using the procedures in your reference material, mount a 3 - jaw chuck on the lathe. Have your instructor evaluate your procedures.

NOTE: You may need to try this a few times before you have your instructor evaluate this Learning Practice.

2. What you have learned in this Task package about mounting the 3 - jaw chuck can be used in mounting a 4 - jaw chuck or face plate on the lathe.

This is a short, but important lesson. Now you are about ready to start running the lathe.

Precision machinists are vital to the industry of your area.

M-VI-2

UNIT VI: THE ENGINE LATHE

TASK PACKAGE #2: 3-JAW OPERATIONS

PREREQUISITES: UNIT II, TASK PACKAGES 1 and 2; UNIT V;
UNIT VI, TASK PACKAGE 1

RATIONALE:

Do you have anything around with which to celebrate? A cake? Candles? This day may take on something of a birthday atmosphere for you.

You are about ready to start machining on the lathe. For many new machinists this is a day they have been waiting for almost as much as their birthday. It may, in fact, be a birthday of sorts if you were not really sure about becoming a machinist before now.

Before starting to cut metal on the lathe (you will get to this in this task package), there are some things you will have to know first. One of these is more information about the lathe and the parts that are used on it. Another item you will have to know is how to grind the tool bits you will be using to cut the workpiece. These you will learn in this task package. This is a lot to learn, and, coupled with the cutting you will be doing, there is a good day's work ahead of you.

[illegible]

OBJECTIVE:

Upon completion of this task package you will be able to use a 3-jaw chuck and appropriate tools to perform facing, turning, parting (cut off) chamfering, and square and filleted shoulders. The standard of accuracy will be determined by the specifications of the drawing of the part.

LEARNING ACTIVITY:

1. View sound-slide programs M-VI-2, M-VI-3, M-VI-3A, M-VI-3B as today's quadruple feature.
2. Reference reading :
   a. Metalwork Technology and Practice, pages 474 to 480, sections 1186 to 1191.
   b. Machine Tool Technology, Units 52 to 56, pages 225 to 241.
   c. Machine Shop Operations and Setups, pages 164 to 196. Note figures 11, 12, 14, 15 and 42. Also, on pages 162 and 163 are five safety rules. Write these below:

      (1)

      (2)

LEARNING ACTIVITY (cont'd):

(3)

(4)

(5)

d. In reference c. read page 197 and note figure 45.

5. Because the amount of material in this Learning Activity is so long, it may be necessary for you to refer to it several times.
6. Go on to your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Lathe with 3-jaw chuck	3. Measuring tools
2. Grinder	4. Tool bits

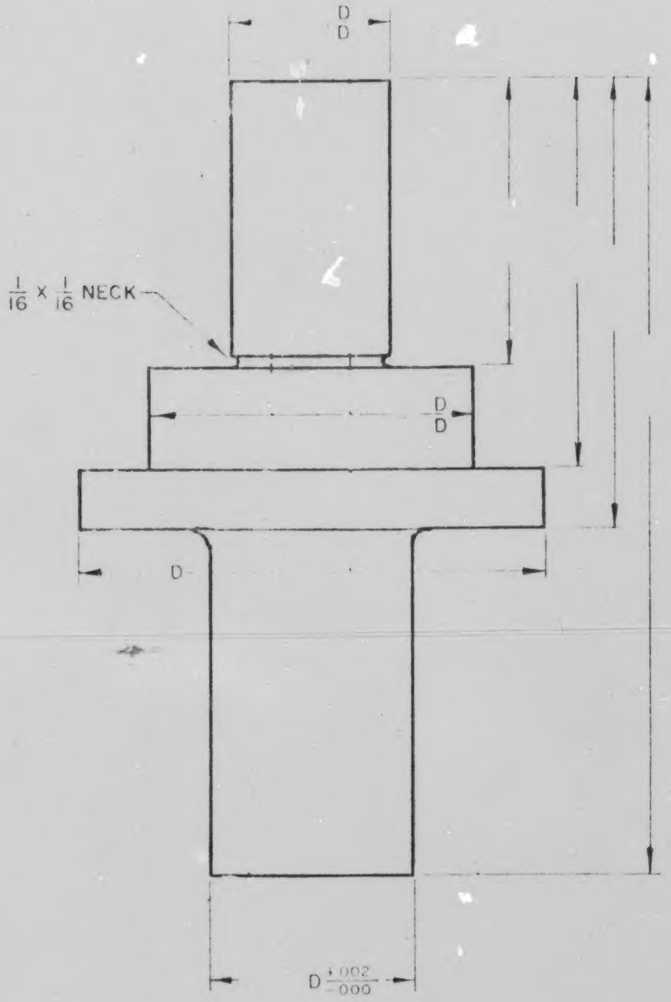
1. Obtain from your instructor some square stock to use as practice pieces for grinding cutting tools.
2. Your instructor will demonstrate the proper grinding of the tool bits.
3. Grind, on the practice square stock, the tool bits you will need.
4. Have your instructor check your practice pieces, and when you are ready, he will issue you tool bits to grind.

LEARNING PRACTICE (cont'd):

5. Obtain from your instructor a piece of round stock, and at this time have him fill in the dimensions on the drawing in this task package.
6. Machine the piece to the specifications of the drawing.
7. Have your instructor check your work. Save this piece of stock for a later task package.

This has been a long task package. You have done a real day's work by finishing it, and have learned many of the operations of the lathe.

Don't jaw around too long now before beginning the next task package!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D
$\frac{1}{16} \times \frac{1}{16}$ NECK
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UNIT VI: THE ENGINE LATHE

TASK PACKAGE 3: TAILSTOCK ADJUSTMENT

PREREQUISITE: UNIT VI, TASK PACKAGE 2

RATIONALE:

There's a time to rise, a time to shine, and a time to align. Precision machining requires the proper alignment of headstock and tailstock. So rise, shine, and align!

Besides the new parts of the lathe you will learn about in this task package, there are two operations that you as a machinist must be able to perform, and these are also included in this package. The first of these operations is aligning the tailstock. Before any accurate work can be machined on the lathe, the headstock and the tailstock must be aligned. Once this has been accomplished, you are then ready to center drill a work piece for further lathe operations.

You will probably find that aligning the tailstock for the first time is a time consuming operation. It takes a great degree of skill to do this, but you will find, as is so often the case, that each time you do this aligning it becomes easier.

You are rapidly increasing your skills as a machinist. Keep up the good work.

OBJECTIVE:

Upon completion of this task package you will be able to use centers for alignment and necessary holding devices to adjust the tailstock to the zero position and prepare it for drilling operations. The standard of acceptance for checking the position of the tailstock will be turning a six-inch piece of stock with a tolerance of ± .001 of an inch from end to end.

LEARNING ACTIVITY:

1. View sound-slide program M-VI-4 for today's matinee.
2. In your reference material read the following:
   a. Technical Metals, Unit 76, pages 343 and 344. Note the following illustrations, 76-1, 76-2, 76-3, 76-6, 76-7, and 76-8.
   b. Machine Shop Operations and Setups, pages 229 and 230.
   c. Machine Tool Technology, Unit 56, pages 241 to 247.
   d. Metalwork Technology and Practice, sections 1191 to 1194, pages 479 to 481. You should also study the Words to Know section on page 493.
3. You are ready to work on the lathe again. Check with your instructor and see what lathe needs its tailstock aligned, then start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Lathe	3. Center drill
2. Dead and live centers	4. Micrometer

1. Set the alignment of the tailstock.
2. Install a 3-jaw chuck on the headstock.
3. Obtain an 8" piece of round stock from your instructor and chuck it in the lathe. This will be your test piece.
4. Center drill one end. See figure 1032, page 479, Metalwork Technology and Practice.
5. Remove the center drill and chuck from the tailstock and install dead center.
6. Chuck the test piece so that at least 6 1/2" are exposed for turning, and set piece in dead center. Make sure you lubricate the dead center.
7. Make a 6" turn on the test piece, then measure both ends with your micrometer. Accuracy should be ± .001 of an inch.
8. Have your instructor check your test piece.
9. After tailstock is aligned, center drill both ends of the piece of stock that you used in your last task package. Keep all stock.
10. Show your work to your instructor, and with his approval go on to the next package.
11. You're the quarterback - call the right plays.

M-VI-4

UNIT VI: THE ENGINE LATHE

TASK PACKAGE #4: 4-JAW OPERATIONS

PREREQUISITE: UNIT VI, TASK PACKAGE 3

RATIONALE:

You have only two jaws. But did you know that some things have twice that many? In this package you will become familiar with one of them - the 4-jaw chuck.

You have used the dial indicator as a testing device and also did some simple measuring with it. Now you will get a chance to use it in conjunction with a machine and in the manner in which it is normally used by the machinist.

In this task package you will also be introduced to the 4-jaw chuck. This is a holding device that you will find to be very versatile and useful, for chucking odd-shaped work pieces. You will also use this chuck for more accurate work, when chucking normally shaped pieces, than you can do in the 3-jaw chuck. The 4-jaw chuck may not seem more accurate than the 3-jaw chuck at first glance, but when you have set up a work piece, using the dial indicator, you will see how accurate the 4-jaw chuck is. This accuracy is one of the reasons machinists use this chuck so often when you might think they would use the 3-jaw chuck. In the machine shop accuracy is your business!

OBJECTIVE:

Upon completion of this task package you will be able to use a dial indicator for truing the work piece for performing appropriate lathe operations in a 4-jaw chuck. The standard of acceptance will be determined by the specifications of the drawing.

LEARNING ACTIVITY:

1. View sound-slide program M-VI-5 for today's attraction.
2. Your reference reading is as follows:
   a. Metalwork Technology and Practice, pages 473 and 474, section 1185. Note figures 1012 to 1014.
   b. Technical Metals, page 349, topic Using Chucks. Also notice figures 76-23, 76-24, 76-25 and 76-26.
   c. Machine Shop Operations and Setups, pages 184 to 186 and figures 27 and 28.
   d. Machine Tool Technology, Unit 66, pages 263 to 266 and notice the figures in this unit.
3. Give two reasons for using a chuck with independent jaws:
   a.
   b.
4. To locate work .001" or closer use a ______________________.
5. When using chalk for centering stock, the chalk mark shows the ______________ spot.

LEARNING ACTIVITY (cont'd):

6. To prevent accidents the _______________ wrench must be removed each time after its use.
7. Answer the above questions, show your work to your instructor and do your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Lathe	3. Dial indicator set
2. 4-jaw chuck	4. Micrometer

1. Using the test work piece from your last task package and the dial indicator, center this work piece in the 4-jaw chuck.
2. Have your instructor evaluate your work.
3. From the drawing used in Task Package 2, subtract .025 of an inch from each dimension.
4. Show this modified drawing to your instructor.
5. Chuck the work piece made from the drawing and cut it to the new dimensions. Use the tailstock and dead center, and don't forget to lubricate the dead center.
6. Have your instructor check your work and save the pieces of stock. You will use them again.

Clean your machine and area. Have you been lubricating the lathe before you use it? This must be done. A good craftsman always takes care of his tools and equipment. If you are enjoying your work you will become an excellent machinist!

M-VI-5

UNIT VI: THE ENGINE LATHE

TASK PACKAGE 5: COLLET ASSEMBLY

PREREQUISITES: UNIT VI, TASK PACKAGE 4

RATIONALE:

As an individual, you like to be original. One way to be original is to design something new - or at least a part of it. Here's your chance for originality. So call on all your resourcefulness in this package.

In this task package you will be asked to combine several things you should have already learned to make a part of your own design.

Many times the machinist is called on to design a part for a certain job. He may have a large quantity of information to help him or he may have very little information; in either case, he must use a great deal of ingenuity and usually all of his skills to do the job. When he is given an assignment, the machinist does it and, since you are the machinist, you can and will do this job. The skilled machinist also asks for help when and if he needs it, and you should do the same thing.

The collet assembly you will be employing in this task package is a fairly simple device to use. It is quick and accurate, so it is used very often in production work.

Have fun with this task package!

OBJECTIVE:

Upon completion of this task package you will be able to use the correct collet assembly to perform appropriate lathe operations in a collet assembly. The standard of acceptance will be determined by the specifications of the drawing and your setup will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View sound-slide program M-VI-6A as today's show.
2. Read and study the following reference material:
    a. Technical Metals, page 343, the topic, The Collet Chuck.
    b. Metalwork Technology and Practice, page 473, topic, Collet Chucks. Look closely at figure 1007 and 1008 on page 472.
    c. Machine Shop Operations and Setups, pages 151 and 152 Note figures 19, 20 and 21.
    d. Machine Tool Technology, page 259, and figures 9-108 and 9-109.
3. The collet chuck is used to hold:
    a. ______________________ stock
    b. ______________________ stock
    c. ______________________ stock
4. Can you do precision work in a collet chuck? ____________

LEARNING ACTIVITY (cont'd):

5. A spring collet chuck should never be used to hold work that is more than __________ of an inch oversize or undersize.

6. Name the five parts of the Draw-in Collet Chuck Assembly:

   a.

   b.

   c.

   d.

   e.

7. Make up a drawing, using the information from Blueprint Reading for Machinists, Units 1 to 11, for machining the test piece of stock you used in the last two task packages. Include the following types of cuts in the drawing and also the dimensions you will machine them to:

   a. Turning
   b. Facing
   c. Square shoulder
   d. Fillet shoulder
   f. Groove

8. Feel free to ask your instructor for help with the drawing. Make the drawing as professional looking as you can - Remember you should be able to hand your drawing and piece of stock to another machinist and he should be able to do the job without asking you questions. You may not be able to do this on your first try, but this is the target you should aim to hit.

LEARNING ACTIVITY (cont'd):

9. Show your piece of stock and drawing to your instructor. You should now be ready for the Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Lathe with collet assembly
2. Measuring devices

1. Chuck the test piece in a collet assembly. (You may have to turn it to fit the assembly.)
2. Machine the workpiece to the specifications of the drawing you made in the Learning Activity.
3. Show the finished part to your instructor.

Friend, if your part came out looking like your drawing you have done an excellent job. Gee! Doesn't it feel great to succeed?

M-VI-6

UNIT VI: THE ENGINE LATHE

TASK PACKAGE #6: FACE PLATE

PREREQUISITE: UNIT VI, TASK PACKAGE #5

RATIONALE:

A face plate is not a catcher's face mask. Neither is it a dental or medical device. Why not become familiar with it here - along with a new breed of dog?

This task package shows you another way of setting up a work piece on the lathe. In this setup you will be using a face plate, centers, and a lathe dog. The lathe dog, by the way, is not a hound that sleeps under the lathe all day.

You should not find the work in this task package to be very hard. Most of it you have done before, and of course you will be doing work like this many times in the future. Don't assume the jobs in the task packages are "busy work"; they are designed to give you all the basic skills you need to enter machine shop work.

Try this easy package; you will like the change.

OBJECTIVE:

Upon completion of this task package you will be able to use a face plate, centers, and lathe dog to perform appropriate lathe operations between centers. The standard of accuracy will be determined by the specifications of the drawing, and your setup will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View sound-slide program M-VI-8A for today's feature.
2. The reading assignments for this task package are:
   - a. Technical Metals, page 342, topic Face Plate and Lathe Dog.
   - b. Machine Shop Operations and Setups, pages 187 to 195, and the topic Lathe Center on page 153. Also note figures 23, 24, and 25 of page 153 and figure 27 on page 154.
   - c. Metalwork Technology and Practice, pages 481 to 484, sections 1194 to 1197. Figures 1037 to 1041 are excellent illustrations of using a face plate and centers.
   - d. Machine Tool Technology, Units 58 to 61, pages 247 to 254. Note the pictures and illustrations.

LEARNING ACTIVITY (cont'd):

3. Measure the part you made in task package #2 of this unit. Use the drawing of that part, enclosed in this task package, and mark in the original measurements. Reduce all measurements by .025 of an inch. This drawing with the new measurements will be used in the Learning Practice.

4. When you have finished your reading assignment you will be ready to start the Learning Practice.

NOTE: By this time you should have seen how important it is for you to thoroughly read and observe the Learning Activity. If at any time you have questions about any of the work in the task package, ask your instructor.

LEARNING PRACTICE:

Tools and Equipment

1. Lathe	3. Lathe dog
2. Face plate	4. Live and dead centers

1. Check the alignment of the centers. You may use any method you wish that will do the job.

2. Chuck the part that you made (not the test piece) in task package #2, between centers.

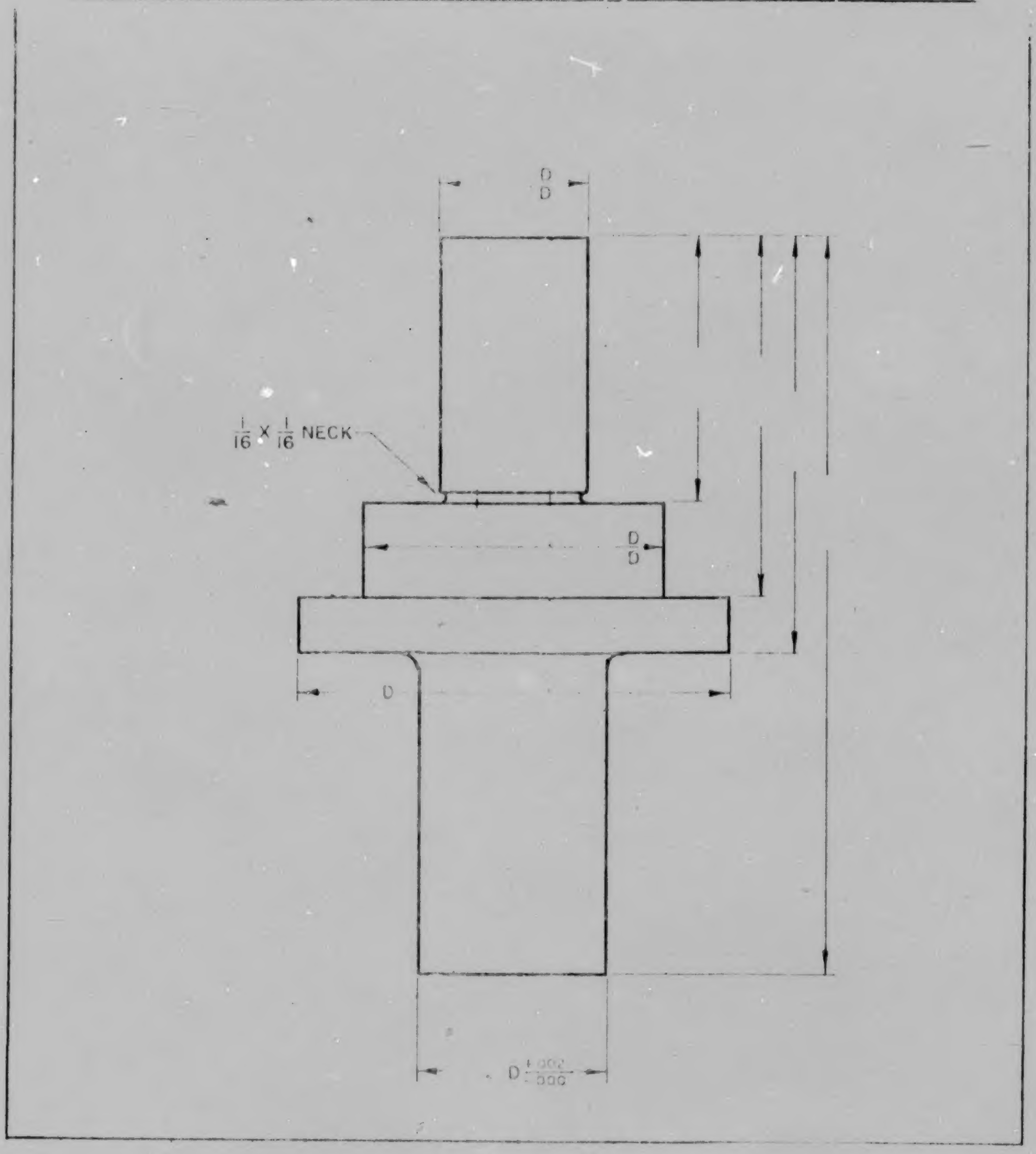
3. Reduce all dimensions by .025 of an inch. Use the drawing from the Learning Activity. Make sure you use the proper tool for each operation.

LEARNING PRACTICE (cont'd):

4. When you have finished, check your work over carefully and then have your instructor evaluate it.
5. Put away your tools and clean up the area. Did you lubricate the lathe?

Are you able to see how you can use different setups on the lathe to accomplish different operations? Don't become rigid in your selection of setups. Use the one that is best for the job you are doing.

Don't imitate a lazy dog. Use the lathe dog!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M-VI-7

UNIT VI: THE ENGINE LATHE

TASK PACKAGE #7: STEADY REST

PREREQUISITES: UNIT VI, TASK PACKAGE #6

RATIONALE:

You get a steady rest and a bonus in this package. Isn't that a rare combination? We all like rest and bonuses, don't we? But not many of us enjoy knurling as a bonus. Read further for details.

This task package will introduce you to two more lathe operations. One of these is using a steady rest for machining a long piece of stock, and the second one is a kind of bonus because you have been doing a good job. The bonus operation is called knurling, and it is a form of metal cutting that you have seen many times and even used on a number of occasions. Knurling is employed for making a grip on metal handles and also on knobs that are turned by hand.

Later on, as you advance in your machine shop work, you will want to make some of your own tools. Often times a machinist finds it necessary to make special tools which have a knurled finish. You can look forward to someday making your own tools.

OBJECTIVE:

Upon completion of this task package you will be able to use a steady rest to turn a long shaft. The standard of accuracy will be determined by the specifications of the drawing. Your performance will be evaluated in accordance with the instructor's check list.

LEARNING ACTIVITY:

1. View slide-sound program #M-VI-10 as today's matinee. ✓
2. Study the following reading assignments:
    a. Technical Metals, page 350, figure 76-29, shows the steady rest being used in a drilling operation.
    b. Machine Shop Operations and Setups, pages 155 and 156. Note figure 28 on page 155. Also pages 195 to 198, the topic Knurling.
    c. Metalwork Technology and Practice, page 486, section 1200, Knurling, and pages 487 and 488, section 1203. Note figure 1058.
    d. Machine Tool Technology, Unit 61, pages 253 to 256; and Unit 63, pages 256 to 258.
3. Another name for the steady rest is ______________________________.

LEARNING ACTIVITY (cont'd):

4. Why should you not draw the tail center too tightly? ________________

____

5. It is often necessary when using the steady rest to lubricate the workpiece where it turns in the steady rest.

6. When knurling, the lathe is set in __________ gear. If you have trouble doing this task package, ask your instructor for help.

7. The longitudinal feed for knurling is ____________ to ______________.

8. The tool-post type of knurler is known as a ___________ ____________ knurler.

9. Don't forget to use oil when you are knurling.

10. Make a working drawing that shows a 24" length of round stock about 3/4 of an inch in diameter being machined with the following operations.

    a. Facing both ends
    b. Center drilling both ends
    c. Knurling 3" of one end
    d. Cutting square shoulders in the end opposite the knurl

    NOTE: Cut the knurl in the chuck end and close to the chuck. Put in the finished dimensions when you receive the stock from your instructor.

11. After your instructor evaluates your work, you should be ready to start your Learning Practice.

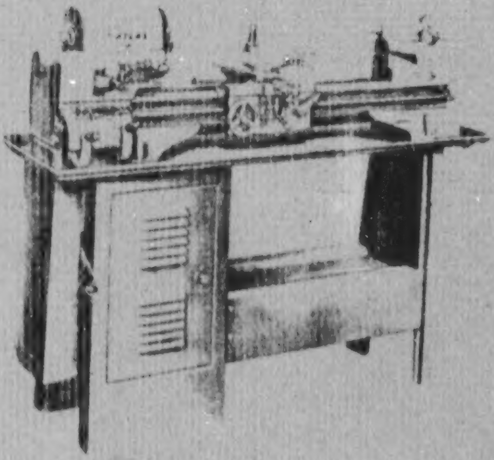
LEARNING PRACTICE:

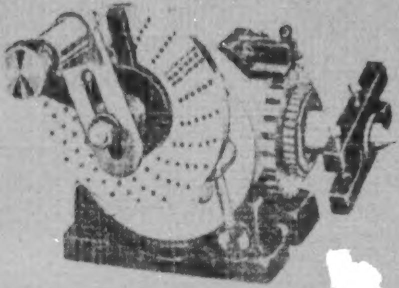
Tools and Equipment

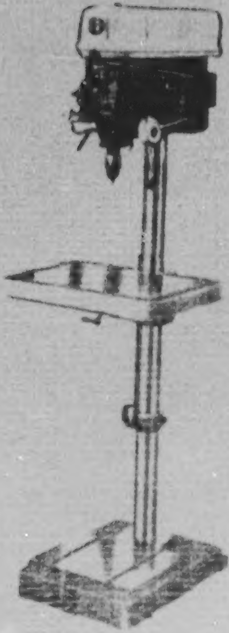
1. Lathe
2. Steady rest
3. Knurling tool

1. Obtain from your instructor a piece of round stock about 24" in length and over 3/4 of an inch in diameter.
2. Face both ends of the stock and center drill.
3. Set up the workpiece in a 3-jaw chuck and use the dead center in the tail stock.
4. Do the machining according to the drawing you made in the Learning Activity.
5. When you are finished, show your drawing and your work to your instructor and clean up the area.
6. Precision is the key that unlocks quality!

RESEARCH PROJECT
SANFORD CENTRAL HIGH SCHOOL
1708 NASH STREET
SANFORD, NORTH CAROLINA 27330







CLUSTER: METALS

COURSE: MACHINE SHOP

CE003931(9)

M-VI-8

UNIT VI: THE ENGINE LATHE

TASK PACKAGE #8: FOLLOWER REST

PREREQUISITES: UNIT VI, TASK PACKAGE #7

RATIONALE:

You, as a follower of the metals program, are entitled to some rest now. Not that you're going to get out of work completely, though. Just read the next paragraph for an explanation.

It is time to give you a little break and have you do a short task package. So far your work has been very good, and just because this is a short package, don't let your work get sloppy.

In this task package you will learn to use the follower rest. It is somewhat like the steady rest you used in the last task package, but this rest does not stay in one place. Instead it is mounted on the carriage of the lathe and moves along behind the tool bit as the tool is cutting. This supports the work piece and allows for accurate cutting of thin shafts.

Pretty smart people, these machinists!

OBJECTIVE:

Upon completion of this task package you will be able to use a follower rest to turn a long, thin shaft. The standard of accuracy will be determined by the specifications of the drawing. Your performance will be evaluated in accordance with the instructor's check list.

LEARNING ACTIVITY:

1. View slide-sound program #M-VI-11 for today's star attraction.
2. Read the following assignments:
   a. Machine Shop Operations and Setups, review pages 155 and 156.
   b. Machine Tool Technology, Unit 61, pages 253 to 256.
3. On the drawing you made for the last task package, (M-VI-7), make the following modification. The end that has the shoulders on it is to be turned for a length of 10" to whichever of the following sizes you can turn it to:

   a. 1/2" b. 7/16" c. 3/8"

NOTE: Try for the largest diameter that you can machine. If your work piece has a diameter smaller than 3/8th of an inch, go to the next larger diameter.

LEARNING ACTIVITY (cont'd):

4. Show your instructor the modified drawing and the piece of stock. With his approval you may start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Lathe
2. Follower rest
3. Tool bit

1. Using a follower rest machine the work piece to meet the specifications of the drawing you made in task package M-VI-7.
2. When you have completed your machining operations, show your work to your instructor.
3. Clean up your area. You did lubricate the lathe before you used it, didn't you?
4. Save your drawing and the work piece. You will need them for a future task package.

This was a short task package, but you deserved it for the good work you have been doing. For a machinist the size of the job doesn't count. What does count is the quality of the job.

A little rest may follow the study of the follower rest.

M-VI-9

UNIT VI: THE ENGINE LATHE

TASK PACKAGE 9: DRILL AND REAM

PREREQUISITE: UNIT VI, TASK PACKAGE 8

RATIONALE:

Drill and ream, ream and drill, drill and dream. You've already passed the dream stage on your way to becoming ~~a~~ machinist. Let's pause here at the drill and ream stage.

You have already used the tailstock on the lathe for center drilling a work piece. In this task package you will again be using the tailstock, but this time it will be for the drilling and reaming of holes. This is a very common machining operation that is performed by the machinist many times during his working day. In learning these operations you will be adding new skills to your growing list of competencies.

Remember, when you are doing these task packages that you are learning the basic machine operations. As a good machinist you will want to improve on these basic skills, and one method of doing this is by employing your imagination as you are working. Look around you and see if there are other ways of applying what you are learning.

It takes brain power to control machine power!

OBJECTIVE:

Upon completion of this task package you will be able to do the following:

a. select and use the correct drill bit for drilling an undersize hole for a given reamer.

b. ream to a given size.

Performance requirements involve an accuracy of + 1/64 of an inch.

LEARNING ACTIVITY:

1. View sound-slide program M-VI-12 as today's attraction.

2. Your reading assignments for this task package are:

   a. Technical Metals, pages 350 and 351, topics Drilling on the Lathe and Reaming.

   b. Metalwork Technology and Practice, section 1198, page 485. Note figure 1050.

   c. Machine Shop Operations and Setups, pages 228 to 230. Notice table 1 on page 229 listing the operations on the lathe.

   d. Machine Tool Technology, Unit 68, pages 267 to 269. Read carefully the procedure for drilling and reaming a workpiece in the lathe.

LEARNING ACTIVITY (cont'd):

3. Can you use taper-shanked tools in a drill chuck?__________

4. Small drills are fed at a __________rate than larger drills.

5. You should always drill a hole at least .002 of an inch undersized when reaming. As an example: if the hole is to be reamed to 3/16th of an inch (.1875), you would then want to drill the hole with a No. 13 drill bit (.1850). What is the difference between these two sizes? ____________________

6. On the drawing of the part you made in task package 2, draw in and mark in the appropriate manner a drilled and reamed hole. Check with your instructor for the size hole to make.

7. When you have completed your work, move on to the Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Lathe
2. Drill bits and reamers
3. Tailstock drill chuck

1. Obtain from your instructor a piece of round stock about 1" in diameter and about 3" in length.

2. Drill and ream a hole less than 1/2 of an inch in this piece of stock.

3. Check your reaming for accuracy.

4. You may drill and ream a 1/16th of an inch larger hole for practice.

LEARNING PRACTICE (cont'd):

5. Drill and ream the hole in your part to the specifications on your drawing. Save the pieces and the drawing for future use.

6. Show your work to your instructor for evaluation.

Clean up! Wash up! Show up for the next task package!

You're really making the scene with the machine!

M-VI-10

UNIT VI: THE ENGINE LATHE

TASK PACKAGE 10: MANDREL

PREREQUISITES: UNIT VI, TASK PACKAGE 9

RATIONALE:

You've heard of Mandrake the Magician. But here we're concerned with Mandrel the Magic Machine Tool. Study it and see what a practical device it is.

In the last task package you learned how to drill and ream a hole. In this package you will put that hole to use by inserting a mandrel in it and doing machine operations on the piece of stock you made in task package two.

You may be wondering at this point why you have been using the same piece of stock for so many task packages. The reason for this is money. Metal stock is very expensive and this is a fact that a good machinist always keeps in mind. You do not waste stock if you can help it. Remember - there is no such thing as scrap in a machine shop!

OBJECTIVE:

Upon completion of this task package you will be able to use the mandrel between centers to perform appropriate lathe operations on a workpiece mounted on a mandrel. The standard of acceptance will be determined by the specifications of the drawing.

LEARNING ACTIVITY:

1. View sound-slide program M-VI-9, today's feature.
2. Read in your reference material the following assignments:
    a. Technical Metals, page 353, topic Turning Work on a Mandrel. Note figures 76-37.
    b. Machine Shop Operations and Setups, page 156, and figure 31 on page 157. Also read page 190 and study figure 36.
    c. Metalwork Technology and Practice, page 487, section 1201 and figures 1055 and 1056.
    d. Machine Tool Technology, Unit 70, pages 271 to 273.
3. Why do you use a mandrel to machine a workpiece?
    a.
4. What is used to extend the adaptability of a mandrel of a given size? ____________________ ____________________
5. If it were necessary, could you make a mandrel? ______________

LEARNING ACTIVITY (cont'd):

6. Using the same drawing as you used in task package 9, reduce all the dimensions by .015 of an inch except the drilled and reamed hole. If you do not have enough stock to make this reduction at certain points, don't do it.
7. Have your work evaluated by the instructor and ask any questions you may have, then start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Lathe
2. Mandrel
3. Drill bits
4. Tailstock chuck

1. Using the workpiece from task package 9, the one in which you drilled and reamed a hole, insert it on a mandrel.

   NOTE: You may have to change the size of the hole by redrilling it to fit the mandrel.
2. Mount the workpiece and mandrel on the lathe, between centers, and remove the material specified by your drawing.
3. Show the completed workpiece and your drawing to your instructor for evaluation.
4. Clean up your machine and area. Did you lubricate the machine before starting to work?

   Are you impressed with the different ways in which you can work a piece of stock on the lathe? There's still more to come, so don't slow down!

   Loafing doesn't get you any bread.

UNIT VI: THE ENGINE LATHE

TASK PACKAGE 11: BORING

PREREQUISITE: UNIT VI, TASK PACKAGE 10

RATIONALE:

Some insects are known as borers, but you don't have to become an insect to do a good job of boring. You just have to be developing your skills as a budding machinist.

In this task package you will find out something that may surprise you a bit. In task package 9 you used a drill bit and reamer to make an accurate hole in a workpiece. Now you are going to find out that this method of making holes is not always completely accurate, but don't worry; the machinist has a method for making a very accurate hole. This method is called boring. (You won't be bored with this task package though.) Boring makes a very accurate hole because it does not depend on the existing hole as a guide. It is in fact independent of the existing hole. Sound confusing? If so, it won't be after you have completed this task package.

OBJECTIVE:

Upon completion of this task package you will be able to use a boring bar assembly to increase the size of a hole, to a given size. Acceptable performance will be a tolerance of ± .001 of an inch.

LEARNING ACTIVITY:

1. View sound-slide program M-VI-13, which is not a show meant to bore you.
2. Reference reading for this task package is:
    a. Technical Metals, page 351, the topic Boring. Note figure 76-31.
    b. Metalwork Technology and Practice, section 1199, pages 485 and 486. Notice figures 1048, 1051 and 1052.
    c. Machine Shop Operations and Setups, pages 232 to 236, the topic Boring in the Lathe. The illustrations and pictures are excellent, so study them well.
    d. Machine Tool Technology, Unit 69, pages 269 to 270. This reference gives you the procedure for boring on the lathe.

LEARNING ACTIVITY (cont'd):

3. The cutting edge of the tool is set at the height of the ____________ ____________ __________ of the work.

4. You will use the ____________ boring bar for small diameter holes.

5. Whenever a hole must be true, the best way to produce it is by ____________________.

6. Boring is the cutting and enlarging of a round hole to make:
   a. A more __________ size.
   b. A hole that will not ______________.
   c. The hole accurate with its ________________.

7. When you have finished with the above answers, show your work to your instructor and go on to your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Lathe
2. Boring bar assembly
3. 4-Jaw chuck
4. Dial indicator

1. In task package 9 you drilled and reamed a hole in a piece of stock about 3" in length and 1" in diameter. Using this same piece of stock, chuck it in a 4-jaw chuck, and practice enlarging the hole with the boring bar. Do not enlarge the hole more than 1/16th of an inch.

LEARNING PRACTICE (cont'd):

NOTE: Have your instructor check your setup before you start boring.

2. Using the part you drilled and reamed a hole in as required in task package 9, increase the size of this hole by 1/16th of an inch. Be very careful if the walls are getting thin, or you might cut through the wall.

3. Show your work to your instructor after you have carefully checked it for accuracy.

Remember that the reason you bore a workpiece is to get an accurate hole. Do you understand why you will not always get an accurate hole with a drill bit and reamer? If you don't take another look at your reference material.

Columbus never gave up. Why should you?

Unit VI: THE ENGINE LATHE

TASK PACKAGE 12: THREADING

PREREQUISITES: UNIT VI, TASK PACKAGE 11

RATIONALE:

Have you ever tried to thread a needle? It's not always easy to do by hand. Well, the type of threading here is quite different. It's another kind of threading process, and it may be easier than threading a needle by hand.

If you have ever put threads on a piece of stock you know it can be a hard job. In this task package you will thread stock, but you will find it's not very hard to put a nice set of threads on a workpiece when you are using the lathe. You will also cut left-hand threads and use a die and diestock with the lathe to cut more threads. In this task package is also a bonus operation that you can perform if you want to add another skill to your list of machinist's skills.

You will not find this an easy task package. When you have a problem or don't understand something, ask your instructor about it. He is there to help you help yourself.

There is no such thing as a dumb question.

OBJECTIVE:

Upon completion of this task package you will be able to use hand ground and formed thread cutting tools, and dies and diestock to thread right-and left-hand threads. The standard of accuracy will be determined by the specifications of the drawing.

LEARNING ACTIVITY:

1. View slide-sound program M-VI-14 as today's super attraction.
2. To help you complete this task package read the following:
    a. Technical Metals, pages 351 and 352, the topics How to Cut Sharp V Threads on the Lathe and Cutting Threads with Taps and Dies on the Lathe.
    b. Metalwork Technology and Practice, section 1204, pages 488 to 492. Also read over the Words to Know section on page 493.
    c. Machine Shop Operations and Setups, pages 201 to 222. This is excellent background information on threading.
    d. Machine Tool Technology, Unit 73, pages 277 to 283. Here are how-to-do-it procedures. Read carefully.

LEARNING ACTIVITY (cont'd):

3. Some things you should know about:
    - a. Thread charts
    - b. Feed charts
    - c. Standard-change gear lathe
    - d. Quick-change gear lathe
    - e. Threading dial
    - f. Center gage
    - g. Formed tool bit
    - h. Hand-ground tool bit
    - i. Left-hand threads
    - j. Right-hand threads
    - k. Die
    - l. Diestock
    - m. Compound angle
    - n. Acme thread
    - o. Square thread
    - p. American Standard thread

    Be able to explain to your instructor the above items.

    Take the time now to write notes on each of these items.

4. Using the drawing you made in task package 8, and the reference material in Blueprint Reading for Machinist, Unit 16, draw threads and label these threads on the drawing. Select the size threads that are appropriate for the workpiece you machined in task package 3.

5. When you have modified your drawing and feel confident that you can explain the above terms to your instructor, see him, and if he tells you to, go on to your Learning Practice. Make sure he checks your drawing and workpiece.

LEARNING PRACTICE:

Tools and Equipment

1. Lathe	3. Dies
2. Threading tool bits	4. Die stock

1. Use the workpiece from task package 8 and the drawing you changed in the Learning Activity in this package to cut external threads on the workpiece.
2. On the same workpiece cut left-hand threads. The size does not matter in this practice.
3. Obtain a piece of stock from your instructor and use a die and diestock to cut threads. Do this on the lathe, please.
4. You may also want to tap a hole or two. If so, use the pieces of stock you have and do so. This is for your own experience and is the bonus operation.
5. Show all your work to your instructor. He will tell you how good a job you have done, or he might want you to practice some more.

Clean Up Time!

Keep threading your way through these task packages!

M-VI-13

UNIT VI: THE ENGINE LATHE

TASK PACKAGE 13: TAPERS

PREREQUISITES: UNIT VI, TASK PACKAGE 12

RATIONALE:

Ready to taper off a little? Well, now's your chance. You won't be cutting a caper here, but cutting a taper.

You have reached the last cutting operation on the lathe with this task package. Think back to all the different operations you have learned since you started these task packages on the lathe. There have been a large number of them.

In this task package you will learn to cut a taper on a piece of stock. This is not an easy job to do, but then there are few jobs that are easy for a machinist. Besides cutting tapers, you will be asked to make some drawings of these tapers before you cut them. This is not an unusual request to make of a machinist. Here again, he must use his brain power to get the job completed.

Brain Work + Muscle Work = Machine Work.

OBJECTIVE:

Upon completion of this task package you will be able to use the compound, offset tailstock, and taper attachment to turn tapers to a specific degree of inches of taper per foot. The standard of accuracy will be determined by the specifications of the drawing.

LEARNING ACTIVITY:

1. View sound-slide programs M-VI-8, M-VI-15 and M-VI-15B as the triple feature.
2. In your reference material read the following:
   a. Technical Metals, pages 346 to 349, the topics Turning Tapers, and Taper Turning with the Taper Attachment. See figures 76-13 to 76-19.
   b. Metalwork Technology and Practice, section 1197, pages 483 to 486. Figures 1047 to 1050 show the three different ways to cut a taper on the lathe.
   c. Machine Shop Operations and Setups, pages 220 to 229. Excellent information on calculating tapers.
   d. Machine Tool Technology, Unit 72, pages 274 to 278. The procedures for all three methods of tapering are covered in this unit.
   e. Mathematics for Vocations, package Number 23.
   f. Blueprint Reading for Machinists, Unit 11.

LEARNING ACTIVITY:

3. You probably felt this question coming, so answer it in the spaces below. The question is, what are the three methods of cutting a taper?

a.

b.

c.

4. What method of tapering is used for short, sharp tapers?

____

5. What method of tapering is used for long tapers?

____

6. Another name for the line-up marks on the tailstock is?

____________________ Marks _____ Hint: Check Technical Metals.

7. When it is necessary to measure the amount of tailstock offset with accuracy, the graduated collar on the ________________ screw is used.

8. Make up three drawings for cutting tapers by each of the three methods. Make sure you state on the drawings the amount of taper, the length of taper and the finished size of both ends.

LEARNING ACTIVITY (cont'd):

Also, the length and diameter of the stock should be on the drawing.

9. Have your instructor check your work and with his permission go on to your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Lathe
2. Taper attachment

1. Using the drawing you made in the Learning Activity, obtain from your instructor three pieces of stock.
2. Cut the tapers on the stock according to your specifications on the drawing.
3. Check your tapers by the specifications on your drawing.
4. Have your instructor evaluate your work.
5. Save the workpieces that you have machined.

Clean up, spruce up, and if you don't have a heavy date tonight, take a fling with another task package.

Don't get uptight - keep doing it right!

UNIT VI: THE ENGINE LATHE

TASK PACKAGE 14: POLISHING

PREREQUISITES: UNIT VI, TASK PACKAGE 13

RATIONALE:

You polish your shoes and your car, don't you? Have you ever polished any apples? Some people do, don't they? At any rate, it's a darn good idea to polish workpieces in the machine shop.

In the past task packages you have made many types of cuts and performed a great many operations on the lathe. You have by no means used all the lathe operations that can be accomplished, but you now have a good basic idea of what a competent machinist can do with this machine. As you work in the machine shop, you will see, if you keep your eyes open, other operations, and in time you will learn to do these. Before this happens, however, there is another operation for you to learn in this task package.

In this task package you will learn to polish workpieces. Polishing is the operation which gives your product a professional look and can, in many cases, make it an object of beauty. As with all operations on the lathe, perform this one with care and craftsmanship.

The professional polishes his product!

OBJECTIVE:

Upon completion of this task package you will be able to use files, abrasive cloth, and lapping compound to surface finish stock. Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View slide-sound program M-VI-16 for today's first-run show.
2. Read the following material in your references:
   a. Machine Shop Operations and Setups, pages 48 to 55, the topic Files, and pages 198 to 201, the topics Filing Work in the Lathe, and Polishing Work in the Lathe.
   b. Machine Tool Technology, Unit 62, pages 255 to 257, and Unit 112, pages 420 to 423.
3. The above references will tell you about filing and using abrasive cloth for polishing on a lathe. Both of these methods will produce a finished surface of good quality, but there are times when a machinist must produce an even better surface finish than these methods can do. For these times, you will use lapping compound for surface finishing. Lapping compound is a fine abrasive powder, made into a paste, by mixing it with vaseline or lard oil.

LEARNING ACTIVITY (cont'd):

It is usually purchased already mixed and in different grades. Check with your instructor and see what kinds of lapping compound you have in your machine shop.

4. Move on into the Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Lathe	3. Abrasive cloth
2. Files	4. Lapping compound

1. Chuck the part you made in task package 2 in the lathe.
2. Select a smooth, double cut file with a handle on it.

NOTE: The handle on a file is a safety feature; never use a file on or off a machine, without a handle.

3. Gently file the rotating surfaces on your part. Break all sharp edges. Adjust speed for the material being cut.
4. Use a strip of abrasive cloth and remove the file marks from the rotating part. (Use a few drops of oil.)
5. Clean the part with a clean cloth and inspect it for scratches and tool marks.
6. Using the back or non-abrasive side of a piece of abrasive cloth, apply lapping compound to the surface of the part, and finish your polishing with lapping compound.

LEARNING PRACTICE (cont'd):

7. Clean and inspect the part.
8. Polish the other pieces you have machined in this unit.
9. Have your instructor evaluate your work.

Your workpieces should have a professional look to them.

Nothing sells the individual machinist better than professional-looking products.

Don't play possum! Play polish!

UNIT VI: LATHE OPERATIONS

TASK PACKAGE 20: TURRET LATHE

PREREQUISITES: UNIT VI, ALL ENGINE LATHE PACKAGES

RATIONALE:

High production machining is one of the most important factors in producing large quantities of duplicate parts in today's modern machine shops. The engine lathe has been by-passed as a high-speed producer of duplicate parts. The turret lathe has taken the place of the engine lathe because of its versatility and multiple tooling. Added to this, the turret lathe has long been known for its ability to hold close tolerances and produce parts with very smooth finishes. Some of the newer model turret lathes are numerically controlled machines whose system of operation is dictated by coded perforations in a paper tape. The automobile industry is one of the leaders in the use of tape controlled machining. This task package is designed to introduce you to the turret lathe and give you an opportunity to get some experience in turning operations with multiple tooling.

OBJECTIVE:

Upon completion of this package you will, on a turret lathe, set multiple tooling for facing, turning outside diameters, drilling and tapping, chamfering a number of workpieces to the specifications on the parts drawing provided in this task package. Your performance will be evaluated in accordance with your instructor's checklist.

LEARNING ACTIVITY:

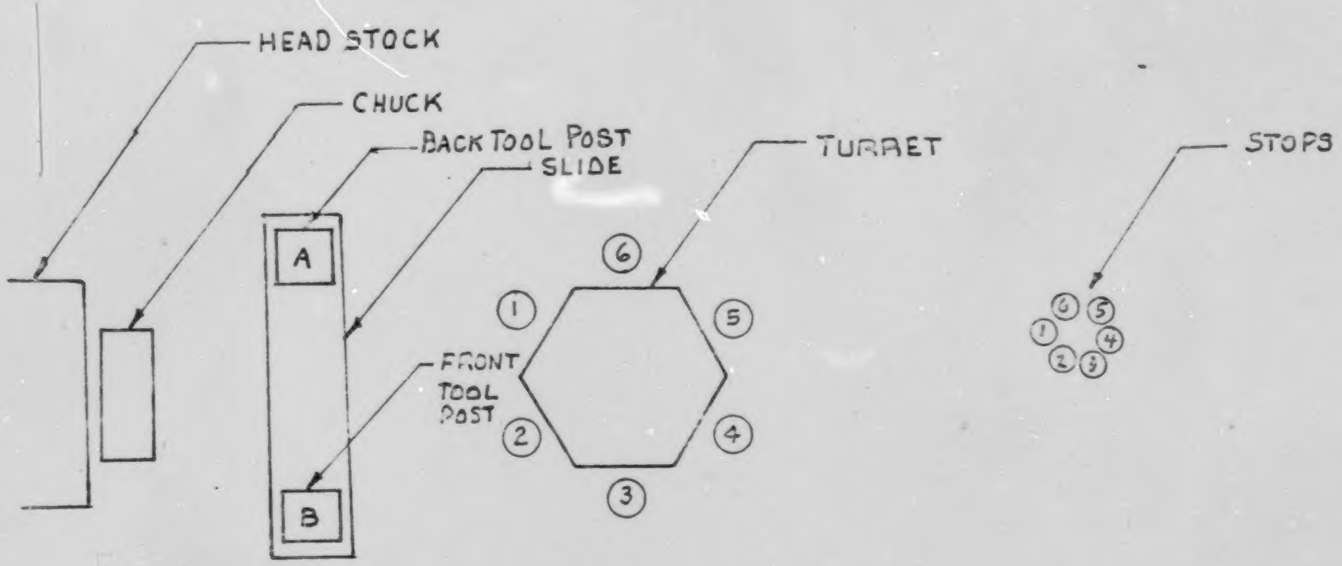
1. View sound-slide program M-VI-20, a multiple single feature.
2. To help you understand multiple tooling on a turret lathe, read the following references:
   a. Machine Tool Technology, pages 23 and 24.
   b. Machine Tool Technology, units 57 and 60.

INFORMATION:

Multiple tooling is required when setting up jobs on the turret lathe. On page 4 is a diagram illustrating the turret lathe layout. The parts are indicated by arrows and will be referred to throughout this package. The headstock function is basically the same as any engine lathe. Usually, the chuck has soft jaws and can be bored out as needed to insure concentricity for inside and outside diameters.

INFORMATION (cont'd):

There are two tool posts mounted on the cross-slide. Each of these tool posts can have as many as four individual tool positions, but normally, we use two on the front and two on the back. The hex turret contains positions for six individual operations such as center drilling, drilling, reaming, tapping and in some cases, turning one or two diameters at one time. At the end of the bed, or the right end of the machine, are six threaded stops that are used to set the length of cut for tools mounted in the turret. There are stops to control the front and back tool posts that control the depth of grooves, etc.



TURRET LATHE LAYOUT

INFORMATION (cont'd):

The general procedure for set-up is as follows:

1. Use the correct size stock for setting tools according to the size requirements of the blueprint.
2. Set the facing tool on the back tool post.
3. Set the center drill on station one on the turret.
4. Set the drilling depth on station two of the turret.
5. Set outside diameters to be turned on the front tool post. In some cases two tools can be set from a special tool holder on a turret station. One will make the roughing cut and the other will make the finishing cut.
6. The cut-off tool and any grooving tool should be set from the front tool post.
7. Chamfers can be set on either the back or front tool post.
8. Remember to set all turret tools in the correct sequence to save operating the turret back and forth unnecessarily.

This is just a suggested list, as situations can cause changes of procedure. Before starting your first project, examine the turret lathe and learn the controls.

LEARNING PRACTICE:

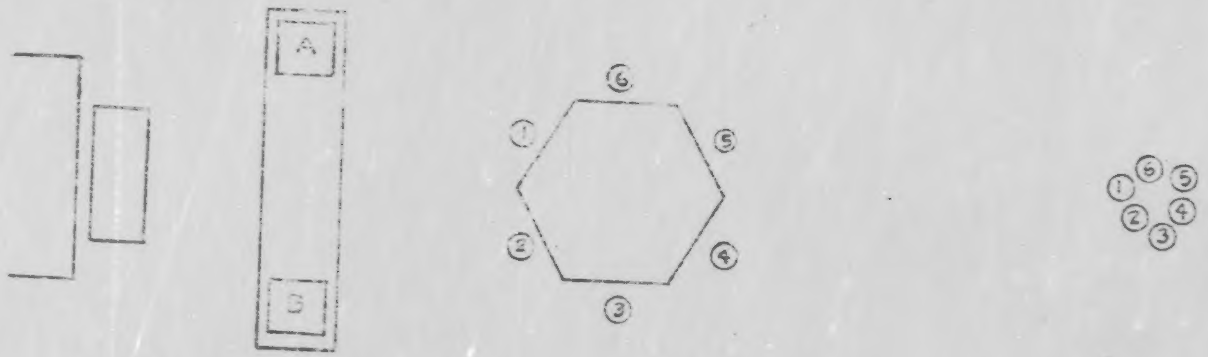
Tools and Equipment

1. Turret lathe
2. Scale
3. 1" micrometer
4. 1" to 2" micrometer
5. File
6. #4 center drill
7. #7 drill
8. 1/4-20-NC-2 tap
9. Two R.H. turning tools
10. Cut-off tool
11. Shim material
12. Magnetic stand and dial indicator

1. Obtain from your instructor, scrap stock 1 1/4 inches in diameter for setting up machine.
2. 1 1/4 bar stock 2 to 24 inches in length.
3. Follow the attached set-up sheets for making the locking stud. Your project requires six uniform parts that will pass inspection according to the dimensions on the blueprint.

Step 1

After securing stock in chuck, check for run-out. Be sure workpiece extends about four inches. Set facing tool to remove approximately 1/16 stock.



A BACK TOOL POST Facing tool ________ ________ ________ ________

B FRONT TOOL POST ________ ________ ________ ________ ________

① Location stop

② ________

③ ________

④ ________

⑤ ________

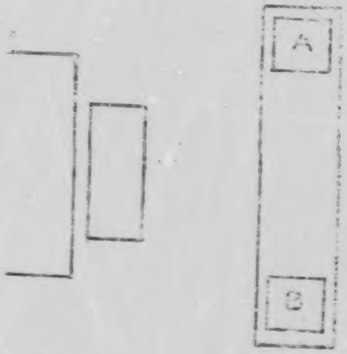
⑥ ________

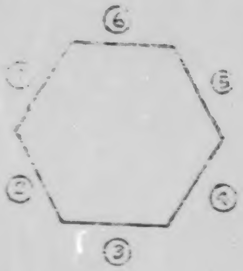
Step 2:

Set tools for rough turning A and B dimensions. Set 2nd set of tools for finish turning A and B dimensions.

Step 3:

Set grooving tool to finish depth.

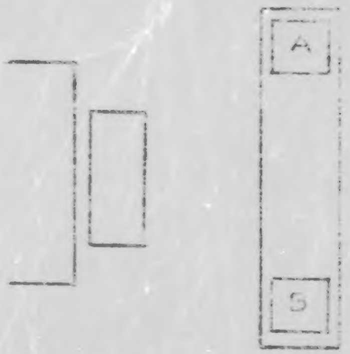


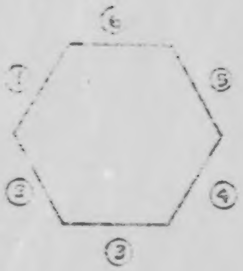


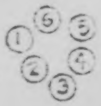
A BACK TOOL POST		1/8 x 1/8 Groove		
B FRONT TOOL POST	Rough "A" Dim.	Rough "B" Dim.	Finish "A" Dim.	Finish "B" Dim.
①				
②				
③				
④				
⑤				
⑥				

Step 4:

Center drill.
Drill with No. 7 drill as per drawing, holding 3/4 dim.
tap 1/4-20-NC-2 as per drawing.







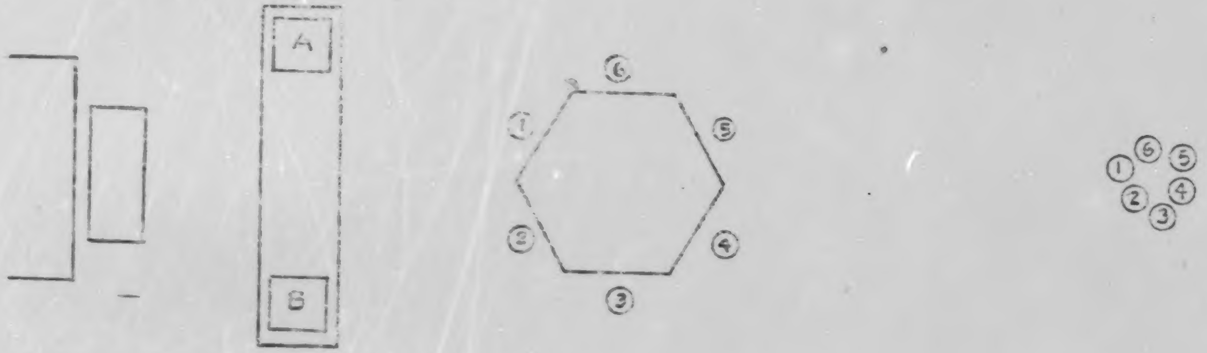
A BACK TOOL POST

B FRONT TOOL POST

①
② Center drill
③ #7 drill
④ Tap 1/4-20-NC-2
⑤
⑥

Step 5:

Set tool for two 1/16 x 45° chamfers. Set cut-off tool for overall length as per drawing.
Caution: Be sure to set depth on back chamfer deep enough to allow for cut-off tool.



A BACK TOOL POST

B FRONT TOOL POST

①

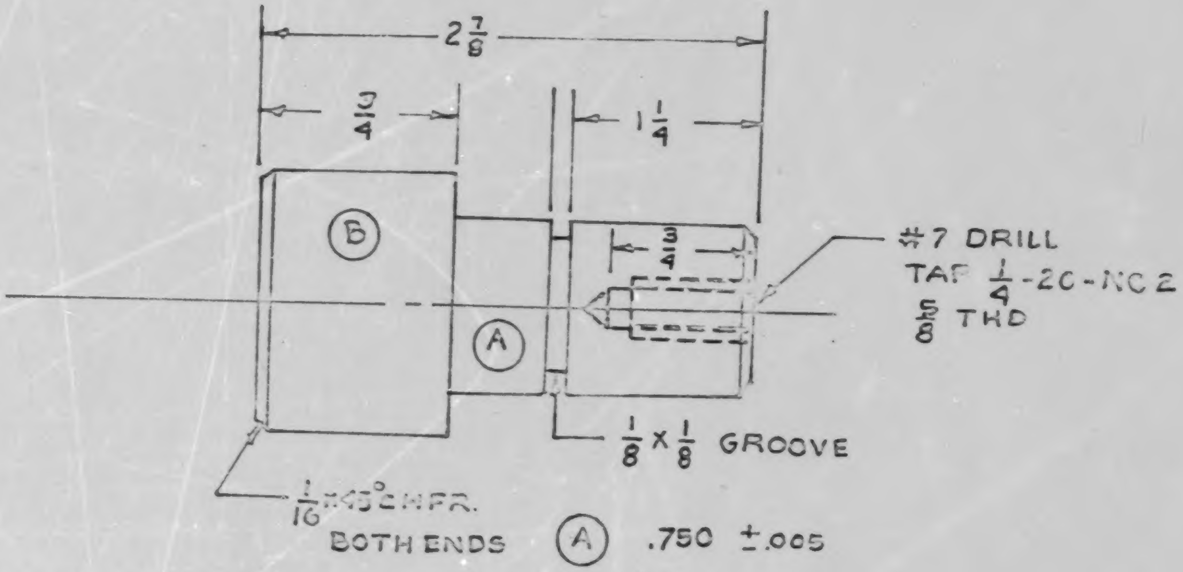
②

③

④

⑤ 1/16 x 45° chfr.

⑥ Cut-off tool



Ⓐ .750 ±.005

Ⓑ 1.125 ±.005

NOTE. FRACTIONS ± $\frac{1}{64}$

NOT TO SCALE

LOCKING STUD

MAT C.D.S.

QUAN. 6

M-VI-20A

UNIT VI: LATHE OPERATIONS

TASK PACKAGE 20A: TURRET LATHE OPERATIONS

PREREQUISITES: UNIT VI, TASK PACKAGE 20

RATIONALE:

Now that you have begun to gain experience in multi-tooling for turret lathe operations, you can see the limitless possibilities for saving time and money in this type of machine shop work. It is now time to take still another step forward in your learning process. This task package is going to introduce you to threading an outside diameter with an automatic diehead and, using a single station on the turret, you will turn the roughing and finish diameters at the same time. This is not as difficult as it seams. Setting up will be no more difficult than the operations done in package 20.

The part drawing in this task package in an actual production set-up would have a machining cycle of approximately three minutes. After completing your set-up check your machining time. You will be surprised at what you can do.

OBJECTIVE:

Upon completion of this package you will be able to set up and turn out required parts with such tooling as the automatic diehead, double tool for rough and finish outside diameters, done simultaneously, and hold prescribed tolerances on a machine drawing.

LEARNING ACTIVITY:

1. Review sound-slide program M-VI-20.
2. Answer the following:
   a. What is the purpose of multiple tooling?
   b. What advantages do turret lathes have over engine lathes?
   c. What is the purpose of boring soft jaws?
   d. What is the function of a numerically controlled turret lathe?

LEARNING ACTIVITY (cont'd):

e. If five stations on a hex turret were needed for a particular set-up, arrange them in the correct order, and explain why.

1) Ream 2) Stop 3) Drill 4) Undercut 5) Center drill

1) ____________ 3) ____________ 5) ____________

2) ____________ 4) ____________

f. Explain the procedure for boring soft jaws.

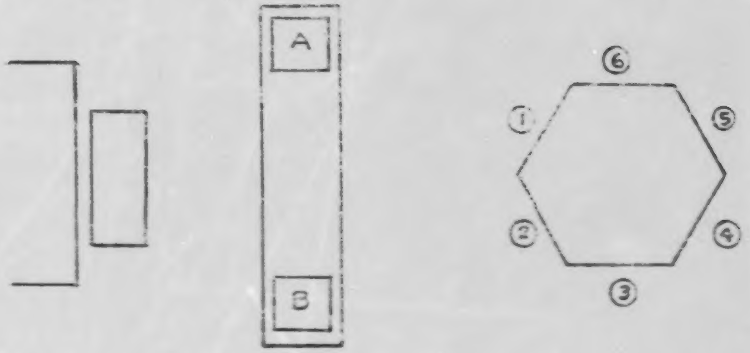
LEARNING PRACTICE:

Tools and Equipment

1. Scale
2. Zero to one micrometer
3. Automatic die head
4. Assorted turning tools

1. Obtain scrap material to set up on the stud from your instructor.
2. Have your instructor assign the machine he wants your project run on.
3. Job requirements are to machine to blueprint Number 10-376, the stud, six pieces are required. Follow the set-up instructions according to tooling sheet number 2.
4. Have your instructor or an inspector, assigned by the instructor, to evaluate your finished products.

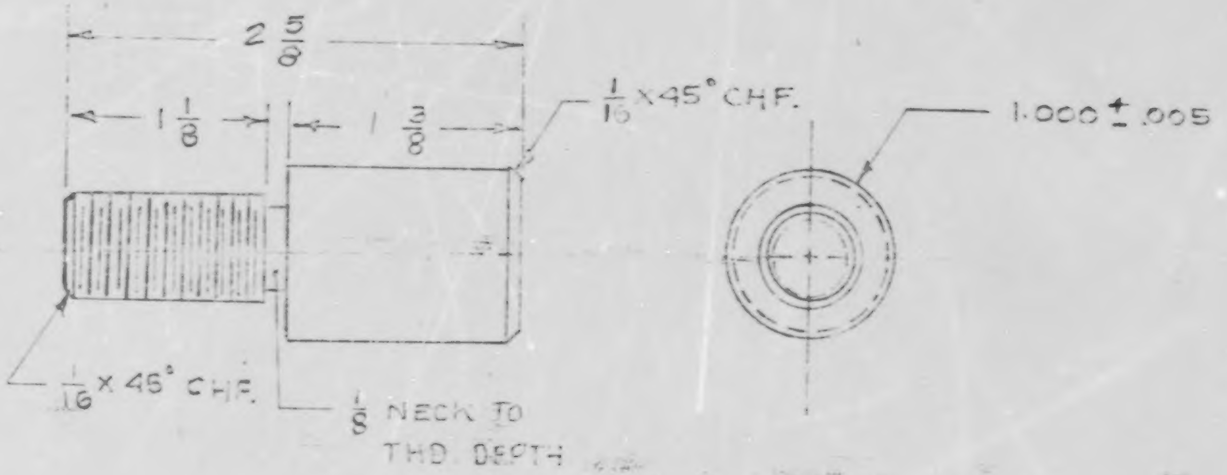
Step 1: Set stop for O.A.L.
Step 2: Set facing tool.
Step 3: Set rough tool for 5/8 Dia.
Step 4: Finish tool for 5/8 Dia.
Step 5: Chamfer 5/8 Dia.
Step 6: Rough and finish 1.000 ± .005 Dim.
Step 7: Plunge 1/8 neck.
Step 8: Thread per drawing.
Step 9: Cut rear chmf.
Step 10: Cut to O.A.L.



A BACK TOOL POST	Face	Chmf. 5/8 D	Rear Chf	
B FRONT TOOL POST	Rough 5/8 D	Finish 5/8 D	Neck	Cut to O.A.L.

① Stop
② Rough & finish 1" Dia.
③ Thread
④
⑤
⑥

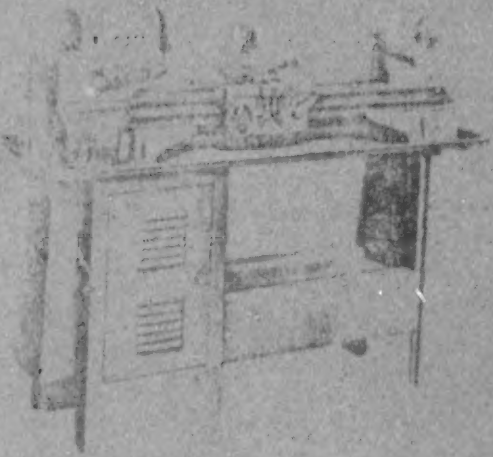
Tooling Sheet No. 2

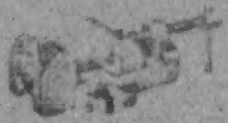


MATERIAL. C.D.S.
THREAD. $\frac{5}{8}$-11-NC-2

	STUD	10-376

RESEARCH PROJECT
SANFORD CENTRAL HIGH SCHOOL
1706 NASH STREET
SANFORD, NORTH CAROLINA 27330





CLUSTER: METALS
COURSE: MACHINE SHOP

UNIT PACKAGE VII: HORIZONTAL MILLING MACHINE OPERATIONS

PREREQUISITES: UNIT I

RATIONALE:

In this unit you will be working with the horizontal milling machine. You will learn in a step by step manner the procedure for setting up and operating this very important machine and you will also learn several basic cutting operations.

While learning and studying about the milling machine you will see that no matter how well a machine is built, or how much it can be made to do, the most important thing is you, the machinist. You are the one who makes the machine perform; you are the one who makes the machine produce a quality product. A quality product can only be produced by a quality machinist.

OBJECTIVE:

General:

Upon completion of this unit you will be able to select cutters, make setups, and perform machining operations on the horizontal milling machine.

Specific:

Upon completion of the task packages for this unit you will be able to:

1. Select the proper cutters for specified types of milling using the reference material. Your performance will be evaluated in accordance with the instructor's checklist.

OBJECTIVES (cont'd):

2. Use the appropriate arbors, collets, holders, and /or adapters for selecting, installing, and removing setups on the milling machine. Your performance will be evaluated in accordance with the instructor's checklist.
3. Use the necessary holding devices to clamp workpieces on the milling machine table in a safe and stable manner. Your performance will be evaluated in accordance with the instructor's checklist.
4. Determine and set the proper feeds and speeds on the milling machine for different milling operations and materials, using reference charts. Acceptable performance will be determined by your instructor's checklist.
5. Use a dial indicator to true the workpiece and/or holding device on the horizontal milling machine. An accuracy of ± .0005 of an inch will be the acceptable standard of performance.
6. Use a cylindrical cutter to mill a flat surface. An accuracy of ± .001 of an inch will be the acceptable standard of performance.
7. Use a face milling cutter to face a vertical surface. An accuracy of ± .001 of an inch to the vertical will be the acceptable standard of performance.
8. Use parallels, solid steel square, and holding devices to reduce the length, width, and thickness of rectangular stock to specific dimensions, retaining its squareness. An accuracy of ± .001 of an inch on all dimensions will be the acceptable standard of performance.

OBJECTIVES (cont'd):

9. Use bevel blocks and/or a universal vise to mill bevels. The standard of accuracy will be determined by the specifications of the drawing.
10. Use the dividing or indexing head to mill flat surfaces on stock. The standard of accuracy will be determined by the specifications of the drawing of the part.
11. Use the straddle mill technique to square and double-groove stock. An accuracy of ± .001 of an inch will be the acceptable performance.
12. Use end mill cutters and holding devices to mill keyways. An accuracy of ± .001 of an inch for both trueness and depth will be the acceptable performance.
13. Use end mills or other suitable cutters and holding devices to mill dovetails, T-slots, and angular cuts. The standard of accuracy will be determined by the specifications of the drawing.
14. Use a standard involute gear cutter to cut a spur gear from a blank. The specifications provided in Machine Shop Operations and Setups, pages 343 to 346, will be used to determine the correct choice of gear cutters. Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

You will have fourteen task packages in this unit that are designed to be worked in sequence. Starting with the first task package in which you will be introduced to the horizontal milling

LEARNING ACTIVITY (cont'd):

machine and the various cutters, you will proceed through each package doing various setups and operations. In the packages you will be asked to view a sound-slide presentation, read and answer questions, and perform some practical exercises. The number and names of the task packages included in this unit are as follows:

TASK PACKAGE 1: CUTTERS
TASK PACKAGE 2: SETUPS
TASK PACKAGE 3: HOLDING DEVICES
TASK PACKAGE 4: FEEDS AND SPEEDS
TASK PACKAGE 5: TRUING
TASK PACKAGE 6: MILL FLAT SURFACE
TASK PACKAGE 7: FACE MILLING
TASK PACKAGE 8: SQUARING STOCK
TASK PACKAGE 9: MILLING BEVELS
TASK PACKAGE 10: INDEXING HEAD
TASK PACKAGE 11: STRADDLE MILLING
TASK PACKAGE 12: MILLING KEYWAYS
TASK PACKAGE 13: MILLING T-SLOTS
TASK PACKAGE 14: SPUR GEARS

If you feel you are qualified to operate the horizontal milling machine without doing the task packages, you may see your instructor about taking the comprehensive unit test. If, however, you are not as yet qualified to run the milling machine, proceed to the first task package and learn to operate the horizontal milling machine.

UNIT VII: HORIZONTAL MILLING MACHINE OPERATIONS

TASK PACKAGE 1: CUTTERS

PREREQUISITES: UNIT I

RATIONALE:

Have you ever heard the expression "to cut the mustard"? Well, you'll be dealing with cutters in this package, but not mustard cutters, whatever they may be. So here's your chance to learn about some other types of cutters in milling so that you can make another kind of bread.

This task package will introduce you to the milling machine and also to the devices that do the work; that is, the milling cutters. You will be asked to familiarize yourself with these cutters, but it will not be necessary to memorize each and every cutter in your reference material. It is more important that you have a general idea of the different types of cutters, and also that you know there are many shapes and sizes of cutters available to you for doing many different jobs.

A mistake made by many beginning machinists, when working on a milling machine, is to try to use the same cutter for all jobs. This may be done out of ignorance or because the machinist is lazy; in either case you should not trap yourself into this kind of unprofessional behavior.

The real pro knows and uses the proper cutter.

OBJECTIVE:

Upon completion of this task package you will be able to select the proper cutters for specified types of milling using the reference material. Acceptable performance will be your instructor's checklist.

LEARNING ACTIVITY:

1. View slide-sound program M-VII-2, today's feature.
2. Reference reading for this task package is:
    a. Machine Shop Operations and Setups, pages 279 to 293. Also, examine the Trans-Vision preceding page 279.
    b. Machine Tool Technology, Unit 87, pages 317 to 328, and Unit 89, pages 333 to 343.
3. Explain the following terms in relationship of the rotation of the cutter to the direction of work feed:
    a. Up milling
    b. Down milling
4. Down milling should be used only on machines equipped with an

_________________________ _________________________.

LEARNING ACTIVITY (cont'd):

5. Milling cutters fall into two major classifications. These are:

   a. ______________________ b. ______________________

6. Give a short general description of the use or uses of each of the following milling cutters:

   a. Plain milling cutters

   b. Side milling cutters

   c. Metal-slitting saws

   d. Angular milling cutters

   e. End milling cutters

   f. Face milling cutters

   g. T-slot milling cutters

   h. Key seat cutters

   i. Form-relieved cutters

LEARNING ACTIVITY (cont'd):

7. It will be necessary for you to have a good knowledge of milling machine cutters for your future task packages.
8. Show your instructor the work you have done, and with his approval, go on to the Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Assorted milling cutters

1. Select milling cutters for the following types of milling:
   a. Milling a wide, flat surface
   b. Face milling a vertical surface
   c. Straddle milling a rectangular shape
   d. Keyway milling
   e. Dovetail milling
   f. T-slot milling
   g. Spur gears
2. When you have made the selection of the cutters, show them to your instructor and he will evaluate your choices.
3. You will be using these cutters in future task packages in this unit. Remember your selection and why you selected the particular cutter.
4. Carefully put away the cutters and prepare yourself for the next task package.
5. You'd climb the highest mountain to become a skilled machinist.

UNIT VII: HORIZONTAL MILLING MACHINE OPERATIONS

TASK PACKAGE 2: SETUPS

PREREQUISITES: UNIT VII, TASK PACKAGE 1

RATIONALE:

You're already familiar with certain types of setups, probably. Haven't you ever set your friends up with a coke or a malt? Well, that's a kind of setup, isn't it? But the setups in this package are a little different.

After selecting the proper milling cutter for a job, it is necessary that the machinist make a choice of holding device for the cutter. In many cases the shape of the workpiece, the material, or the type of cutting to be done helps the machinist in his choice of setup. Even with this help, the final decision for the setup must be made by you, as the machinist. This means you must have a good idea of the types of setups that can be made and for what types of milling these are used.

It is the purpose of this task package to introduce you to the different setups and have you do them. Knowing this information will help you become a proficient craftsman.

Proficiency is your most important product!

OBJECTIVE:

Upon completion of this task package you will be able to use the appropriate arbors, collets, holders, and/or adapters for selecting, installing, and removing setups on the milling machine. Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View slide-sound program M-VII-2, today's extravaganza.
2. Reference reading for this task package is:
   a. Machine Shop Operations and Setups, pages 293 to 297, pages 317 to 323, and pages 327 to 330.
   b. Machine Tool Technology, page 342, the topic The Hand of a Milling Cutter and the remainder of the unit to page 347.
3. Most manufacturers have adopted the standard ______________ ______________ ______________ taper.
4. This taper is available in four sizes. List the sizes:

   a. b. c. d.

5. What are the three styles of arbors used on a milling machine?

   a. b. c.

LEARNING ACTIVITY (cont'd):

6. Briefly describe these arbors:

   a.

   b.

   c.

7. Holders are used for ______________________________.

8. What is used to help keep the arbor straight and rigid?

   ______________________ ____________ collars.

9. Adapters are devices used to mount ______________ of various types and sizes on a milling machine ____________.

10. The shell end mill is a style __________ ______ arbor.

11. When you have completed your reading assignments and answered the above questions, show your work to your instructor. This is a good time to get him to answer any questions you may have. Start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Horizontal milling machine
2. Arbors
3. Collets
4. Holders
5. Adapters
6. Necessary tools

LEARNING PRACTICE (cont'd):

1. Your instructor will demonstrate how to make a setup on the milling machine.
2. Make the following setups on the milling machine and have your instructor evaluate each setup:
    a. Using the collet adapter and an end mill.
    b. Using the A arbor and helical milling cutter.
    c. Using the B arbor and helical milling cutter.
    d. Using the C arbor and a face milling cutter.
3. These are the basic setups for the milling machine.

You will be using these in future task packages, so make sure you understand how to do these setups.

Carefully clean up your working area and put away the tools and equipment you have been using.

Remember in the future, when you begin to use the milling machine, that you must lubricate your machine before you run it.

Nice going there! Treat yourself to a drink of water and celebrate.

UNIT VII: HORIZONTAL MILLING MACHINE OPERATIONS

TASK PACKAGE 3: HOLDING DEVICES

PREREQUISITES: UNIT VII, TASK PACKAGE 2

RATIONALE:

Hold on to what you have learned up to this point. All your knowledge will uphold you as you continue to progress. Now, take a hold of this package on holding devices.

You have learned to select milling cutters and install them in previous task packages. In this task package, you will learn how to clamp the workpiece to the milling machine table, using various holding devices. You will learn to do this in a safe manner and at the same time in a way best suited for the job you are working on. Sounds like a tall order, doesn't it? Don't be too concerned; you will be able to master this task package just as you have the other ones.

These task packages that are leading up to the actual milling of metals are very important. From these, it is hoped that you will develop the habits of good craftsmanship while you are still training to become a machinist.

Bad habits on the job may mean no job!

OBJECTIVE:

Upon completion of this task package you will be able to use the necessary holding devices to clamp workpieces on the milling machine table in a safe and stable manner. Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View slide-sound program M-VIII-2, a gee whizzer.
2. To help you complete this task package, read the following:
   a. Machine Shop Operations and Setups, pages 296 to 300.
   b. Machine Tool Technology, observe the following figures on the pages listed (note how the different holding devices are used):

Page Number	Figure
317	11-1
320	11-5
322	11-9
323	11-11
328	11-20, 11-21
330	11-28, 11-29
331	11-30, 11-31

LEARNING ACTIVITY (cont'd):

Page Number	Figure
332	All pictures
343	11-69
344	11-71

You should have noticed in looking at all of these different figures that the methods of holding workpieces on the milling machine are endless in their variety.

3. In Machine Tool Technology, pages 327 and 328, are a list of safety precautions. Write numbers 2, 3, 4, 8, 11, 12, and 14 in the spaces below:

a.

b.

c.

d.

LEARNING ACTIVITY (cont'd):

e.

f.

g.

4. After listing these safety rules, show them to your instructor. Go on to your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Horizontal milling machine
2. Holding devices

1. Obtain from your instructor four workpieces. He will instruct you as to where these pieces will be milled.
2. Make four different setups, using the best holding devices for each of these workpieces.
3. Examine the workpiece and determine what method you will use for holding it to the table.

LEARNING PRACTICE (cont'd):

4. Take into consideration the construction of the workpiece, the type of milling operation, and the type of cutter to be used.
5. After each setup, have your instructor evaluate your work.
6. Do not get into the bad habit of trying to use only one type of setup for all milling operations.

A major point that is made, or a lesson you should have learned in this task package, is the one of safety. Never compromise safety!

You're really holding your own as a budding machinist.

UNIT VII: HORIZONTAL MILLING MACHINE OPERATIONS

TASK PACKAGE 4: FEEDS AND SPEEDS

PREREQUISITES: UNIT VII, TASK PACKAGE 3

RATIONALE:

You have to feed yourself every day, don't you? Do you feed yourself at the proper speed? Feed and speed must be coordinated in the machine shop, as you will note in this package.

When cutting metal on a milling machine, it is sometimes difficult for the new machinist to get professional looking cuts and also to get the required degree of accuracy. A major reason for these problems is a lack of knowledge of the effects of milling cutter speed and workpiece feed on the final product.

In this task package you will find out about feeds and speeds, and their relationship to milling a workpiece. You will also find that you can, with some help from reference charts, quickly determine the best feeds and speeds for the type of material being milled and also for the type of milling operation being performed. After determining feeds and speeds you will also get a chance to apply this knowledge by making these settings on the milling machine. You should find this package to be interesting and a bit short.

OBJECTIVE:

Upon completion of this task package you will be able to determine and set the proper feeds and speeds on the milling machine for different milling operations and materials, using reference charts. Acceptable performance will be determined by your instructor's checklist.

LEARNING ACTIVITY:

1. View slide-sound program M-VIII-5, an MGM (Machining Generates Moola) production.
2. Read in your reference materials the following:
   a. Machine Shop Operations and Setups, pages 280 to 283, the topic, Feeding the Work; and pages 322 to 327, the topic, Speeds and Feeds for Milling.
   b. Machine Tool Technology, pages 323 and 324, the topic, Speed and Feed; and Unit 90, pages 347 to 352.
3. When reading Unit 90 in Machine Tool Technology, pay particular attention to tables 10 and 11 and to the footnotes under these tables.
4. Cutting speed is the distance which the outer ________________ ____________ of a milling cutter tooth travels in ____________ a minute.
5. High cutting speed will cause the cutter to ______________ and become __________________.

LEARNING ACTIVITY (cont'd):

6. Low cutting speed causes a low and inefficient _________ rate.

7. From the above answers it can be seen that is is better to be on the _______________ side of the cutting speed.

8. List the seven factors that affect cutting speed:

   a.

   b.

   c.

   d.

   e.

   f.

   g.

9. Calculate the approximate rpm for a 4" cutter which is to mill aluminum at 500 sfpm.

LEARNING ACTIVITY (cont'd):

10. From tables 10 and 11 in reference b, determine the cutting speeds and feeds for the following:

Material	Speed	Cutter type	Feed	Cut Type
a. Low-carbon steel		Face		Rough
b. Low-carbon steel		Side		Finish
c. Gray cast iron, soft		End		Rough
d. Gray cast iron, soft		End		Finish
e. Aluminum		Plain (HD)		Rough
f. Aluminum		Plain (HD)		Finish

11. Have your instructor evaluate your work. Learning Practice is next.

LEARNING PRACTICE:

Tools and Equipment

1. Horizontal Milling Machine

1. Your instructor will demonstrate setting feeds and speeds on the milling machine.
2. After the demonstration, set the feeds and speeds, on the milling machine, that you determined from tables 10 and 11 in your Learning Activity. Do not turn on the milling machine until your instructor tells you to.

LEARNING PRACTICE (cont'd):

3. Use the midpoint in the cutting speed range.
4. Have your instructor give you an overall evaluation. If he thinks you are weak in some area, he may want you to do some additional work in this area. Remember he is trying to help you become a good machinist.

You are ready to proceed to your next task package.

Skilled machinists don't grow on trees. They come from doing task packs like these.

UNIT VII: HORIZONTAL MILLING MACHINE OPERATIONS

TASK PACKAGE 5: TRUING

PREREQUISITES: UNIT 7, TASK PACKAGE 5

RATIONALE:

It's true that truing pays off. If precision is to be obtained, the holding device and/or workpiece must be trued. So step true into this package and truly learn about truing.

You are ready to do the fifth of the five basic steps for setting up the horizontal milling machine. You have learned to select the cutter, install the arbor, clamp the workpiece, set the speed and feed, and now you will learn to true the holding device and/or workpiece.

Sorry, but you don't get to do any milling in this task package; however, you will in the next one. So don't delay, start right away, and maybe in a couple of days you will be milling away.

OBJECTIVE:

Upon completion of this task package you will be able to use a dial indicator to true the workpiece and/or holding device on the horizontal milling machine. An accuracy of ± .0005 of an inch will be the acceptable standard of performance.

LEARNING ACTIVITY:

1. View slide-sound program M-VIII-4, a real extravaganza.
2. Information for this task package will be found in:
   a. Machine Shop Operations and Setups, pages 328 and 329, the topic, Mounting Workpiece and Cutter.
   b. Machine Tool Technology, page 352, the topic, Procedure for Roughing Cut. Note procedure 4 in particular and figure 11-90.
3. From reference b. on pages 327 and 328, write the following safety rules in the spaces below. Numbers 1, 5, 6, 7, 16, 19, and 20.

   a.

   b.

   c.

LEARNING ACTIVITY (cont'd):

d.

e.

f.

g.

4. Safety rule 9 on page 327 does not make sense the way it is written. If you add the word "then" between the words "hand" and "with" it will become clearer. The rule is: Tighten the arbor nut by hand, then with a wrench. This rule now makes more sense, and there is a lesson here you should learn. A small oversight or mistake can make a big difference in the final outcome of something. Now let's go back to the rule and see what it means to you. Any time you are putting threaded parts together you should always start the parts by hand. Only when you have turned the part by hand until you no longer can, should you then use a wrench. This helps prevent cross-threading.

5. Your instructor should now check your work and you should be ready for your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Milling machine
2. Holding device
3. Dial indicator
4. Necessary tools

1. Secure a vise to the milling machine table.
2. Place an arbor in the milling machine.
3. Attach a dial indicator to the arbor.
4. Line up the holding device parallel to the machined face of the column.
5. Using the dial indicator, align the vise parallel to the column to an accuracy of ±.0005 of an inch.
6. Have your instructor check your work.
7. Place a workpiece in the vise, turn the vise 90°, and realign the workpiece using the dial indicator. Your accuracy should be ± .0005 of an inch.
8. Have your instructor check your work.

You have now covered all the basic steps in setting up the milling machine for milling. The actual milling of a workpiece will come in the next task package.

Looks as if you're on your way to becoming a true machinist.

UNIT VII: HORIZONTAL MILLING MACHINE OPERATIONS

TASK PACKAGE 6: MILL FLAT SURFACE

PREREQUISITES: UNIT VII, TASK PACKAGE 5

RATIONALE:

This in a way is a red-letter day. It's the day you start your first milling operation. Don't feel nervous. Your instructor will be around to assist you if you need it. Remember, he wants to help you become a machinist and he can only do this if you let him know when you need help.

The first milling operation will involve making a few straight cuts. This may not sound like much, but it is a basic type of milling, and from this you will build your skills and improve your craftsmanship. In a short time, you will be able to do complex milling operations that will amaze you.

The time is now, to start to mill!

OBJECTIVE:

Upon completion of this task package you will be able to use a cylindrical cutter to mill a flat surface. An accuracy of ± .001 of an inch will be the acceptable standard of performance.

LEARNING ACTIVITY:

1. View slide-sound program M-VII-6.
2. Read the following reference materials:
   a. Machine Shop Operations and Setups, pages 327 to 331, up to Face Milling.
   b. Machine Tool Technology, Unit 91, pages 351 to 355.
3. Plain milling is also called ________________ milling.
4. When you have a wide, flat surface to be milled, this is called ________________ milling.
5. Skill in the operation of a milling machine is principally a matter of knowing:
   a.
   b.
   c.
   d.
   e.

LEARNING ACTIVITY (cont'd):

f. How to sharpen the cutter when necessary. You will not be asked to do this in this course, but someday you will have to learn how to sharpen milling cutters.

6. From page 327, reference b, write the following safety rules in the spaces below: 10, 13, 15, 17, and 18.

a.

b.

c.

d.

e.

7. You are ready to begin cutting on the milling machine, after your instructor approves your work.

LEARNING PRACTICE:

Tools and Equipment

1. Horizontal milling machine
2. Holding device
3. Dial indicator
4. Micrometer

1. Obtain from your instructor a flat piece of steel about an inch thick, six inches long, and three inches wide.

LEARNING PRACTICE (cont'd):

2. Select the cutter for the milling operation.
3. Secure the holding device on the table.
4. Clamp the workpiece.
5. Align the workpiece.
6. Set the speed and feed.
7. Install the cutter.
8. Have your instructor check your setup.
9. Remove .045 of an inch from the workpiece. Make sure you check the thickness of the workpiece before milling. Your accuracy should be ± .001 from end to end.
10. Have the instructor check your work.
11. Remove the workpiece from the milling machine and keep it for use in future task packages.
12. Clean up the machine and area.

Well, you did it. Your first milling operation. If you feel like doing some more, there's another task package waiting for you.

The mills of the gods may grind slowly, but you're milling cool and fast.

UNIT VII: HORIZONTAL MILLING MACHINE OPERATIONS

TASK PACKAGE 7: FACE MILLING

PREREQUISITES: UNIT VII, TASK PACKAGE 6

RATIONALE:

You don't have to face the music in this package. You need to come face to face with face milling. So put on a happy face and start milling.

In the last task package you milled the surface of a piece of steel. Now, using this same workpiece, you will learn another milling operation that is equally important; that is, face milling. The importance and many uses of this operation will become apparent to you as you look over your reference material.

You will find in this and other task packages that the milling machine is a versatile machine. The history of the milling machine goes back to the 1790's, and one of its first uses was in making parts for muskets. Eli Whitney (the same one who invented the cotton gin) received a contract from the United States Government to produce ten thousand muskets with interchangeable parts. Because there was a shortage of skilled gunsmiths, he was forced to use unskilled local help. To overcome the problems caused by unskilled help, he developed milling machines. Oh, yes, he finished the muskets in time for their use in the War of 1812.

OBJECTIVE:

Upon completion of this task package you will be able to use a face milling cutter to face a vertical surface. An accuracy of ± .001 of an inch to the vertical will be the acceptable standard of performance.

LEARNING ACTIVITY:

1. View sound-slide program M-VIII-7, featuring Baby Face Milling.
2. For help with this task package, read the following references:
    a. Machine Shop Operations and Setups, pages 330 and 331, the topics Face Milling and Suggestions on Face Milling.
    b. Machine Tool Technology, Units 92 and 93, pages 355-358.
    c. If you have not already done so, study Units 5 to 11 in Blueprint Reading for Machinists.
3. When using face milling cutters that can not be bolted to the milling machine spindle, you would use a style ________________ arbor.
4. When face milling, the teeth on the ____________________________ do most of the cutting.
5. Have your instructor look at your work and, when you are ready, go on to the Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Horizontal milling machine
2. Holding device
3. Vernier caliper
4. Dial indicator

Note - Lubricate the machine before you run it.

1. Using the piece you surface milled in the last task package, make a setup for face milling the ends.
2. Select a face milling cutter and arbor.
3. Clamp your workpiece to the milling machine table.
4. Determine the proper feeds and speeds, and set these on the machine.
5. Install the cutter and arbor.
6. True the workpiece.
7. Have your instructor check your setup.
8. Face mill one end of the block. Remove enough material to have a clean cut across the entire end.
9. Face mill the other end. Make sure you true the workpiece before you start your cut.
10. Check your length measurement. The length of the stock, or part, should be accurate to within ± .001 of an inch. Use the vernier calipers to check the length.
11. Show your work to your instructor for evaluation.
12. Remove the setup from the milling machine if your instructor has passed your work.

LEARNING PRACTICE (cont'd):

13. Clean up the machine and area; carefully put away the milling cutter.

14. Keep your milled part for use in other task packages.

You may feel you are progressing too slowly and the job you are working on is too simple, but don't be impatient; there will be more than enough complex jobs in the future.

You faced up to this task package well. Now, about face, and right on to the next craft skills!

UNIT VII: HORIZONTAL MILLING MACHINE OPERATIONS

TASK PACKAGE 8: SQUARING STOCK

PREREQUISITES: UNIT VII, TASK PACKAGE 7

RATIONALE:

You don't have to be a "square" in order to square stock. But you need to exercise a little skill in the process. So get squared away now for squaring stock.

Having now milled and faced a workpiece you will, in this task package, reduce its size in all dimensions to a size specified by your instructor.

This is a very useful skill for you to acquire. Many times the machinist mills stock in this manner to prepare it for future machining operations. The accuracy called for in this task package is necessary, and in many cases you will be required to do even more accurate work. For example, a production job of hundreds of pieces might be needed; you as a machinist may be called on to mill these to a certain size with an accuracy of ± .0005 of an inch, because this stock will be used in a highly accurate jig or fixture. If the workpieces are not accurate, there may be a slowdown in production. Production slowdowns produce unhappy bosses, who in turn may look for other machinists. Be accurate; keep the boss happy.

OBJECTIVE:

Upon completion of this task package you will be able to use parallels, solid steel square, and holding devices to reduce the length, width, and thickness of rectangular stock to specific dimensions, retaining its squareness. An accuracy of ± .001 of an inch on all dimensions will be the acceptable standard of performance.

LEARNING ACTIVITY:

1. View slide-sound program M-VII-8, a square shooting show.
2. Read the following reference materials:
   a. Machine Shop Operations and Setups, pages 331 to 335, the topics End Milling and Side Milling.
   b. Machine Tool Technology, Unit 92, pages 355 to 357. This is review reading, but study it closely.
3. In reference a., there are some safety rules on page 306. In the spaces below write rules number 2, 4, 5, and 6.

a.

b.

c.

d.

LEARNING ACTIVITY (cont'd):

4. Are you having trouble with your mathematics skills? If so, there are Mathematics for Vocations packages that can help you sharpen your skills. The machinist must know mathematics.
5. Increase your knowledge of blueprint reading by studying Units 11 and 12 in Blueprint Reading for Machinists.
6. You should be ready now to go to work on the milling machine again. See your instructor for permission to proceed to the Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Horizontal milling machine
2. Holding device
3. Parallels
4. Steel square
5. Vernier calipers
6. Micrometer
7. Dial indicator

1. Using the part you have milled in the previous task packages, reduce it in size on all its surfaces.
2. Your instructor will tell you what the final size of the part should be. Don't forget that an accuracy of ± .001 of an inch will be the accepted standard.
3. Plan how you are going to do this job. It may be wise to list the cutters, arbors, and other information you will need for this machining operation. A good machinist is not afraid to write.

LEARNING PRACTICE (cont'd):

4. Select the cutters you will use.

5. Install the holding device and clamp the workpiece.

6. Set the feed and speed.

7. Install the cutter and arbor.

8. True the workpiece for the first cut.

9. Have your instructor check the setup.

10. Mill the first surface.

11. After milling each surface, make the next setup, but don't cut until the instructor checks each new setup.

12. Check the part for accuracy after the final machining operation.

13. Have your instructor check your work.

14. If your work is accurate and has passed your instructor's inspection, clean up your machine and area.

15. Save your part for future use.

You have reduced a workpiece in all its dimensions for future use. With some imagination, you can see that this will be a very useful skill in future machining operations.

Success is a play. Keep rehearsing.

M-VII-9

UNIT VII: HORIZONTAL MILLING MACHINE OPERATIONS

TASK PACKAGE 9: MILLING BEVELS

PREREQUISITES: UNIT VII, TASK PACKAGE 8

RATIONALE:

It's time now to level with the task of milling bevels. This work will require you to summon up your various skills and apply them to the job at hand. Are you ready to level with the bevel?

Combining skills is one of the traits of the professional machinist. While you are not a professional machinist as yet, it is never too soon to start picking up these traits that make a good machinist.

In this task package you will have to work with and from a simple drawing. You will also use some of the skills that were learned in Unit I to help you complete the milling operation required by this task package. As you can see, you will be combining a knowledge of print reading, measuring skills, and machining techniques to complete the job.

It takes brains to be a machinist; maybe that's why you are becoming one!

OBJECTIVE:

Upon completion of this task package you will be able to use bevel blocks and/or a universal vise to mill bevels. The standard of accuracy will be determined by the specifications of the drawing.

LEARNING ACTIVITY:

1. View sound-slide program M-VII-10, starring Millie Bevel.
2. Reference reading for this task package:
    a. Machine Shop Operations and Setups, page 332, figure 21, shows a type of bevel being milled.
    b. Machine Tool Technology, Unit 94, pages 358 and 359.
    c. Restudy Unit 9 in Blueprint Reading for Machinists.
3. Use the part you machined in the previous task package, for all of the exercises found in the test below.

    L = Length T = Thickness W = Width
4. Fill in the dimensions in the spaces below of the part:

    L = ____________, 1/2 L = ____________, T = ____________,

    1/2 T = ____________, W = ____________, 1/2 W = ____________.
5. When you have finished the above, show your instructor your work and start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Horizontal milling machine
2. Universal vise or bevel blocks
3. Bevel protractor head and blade
4. Surface gage
5. Combination square head
6. Layout tools and fluid

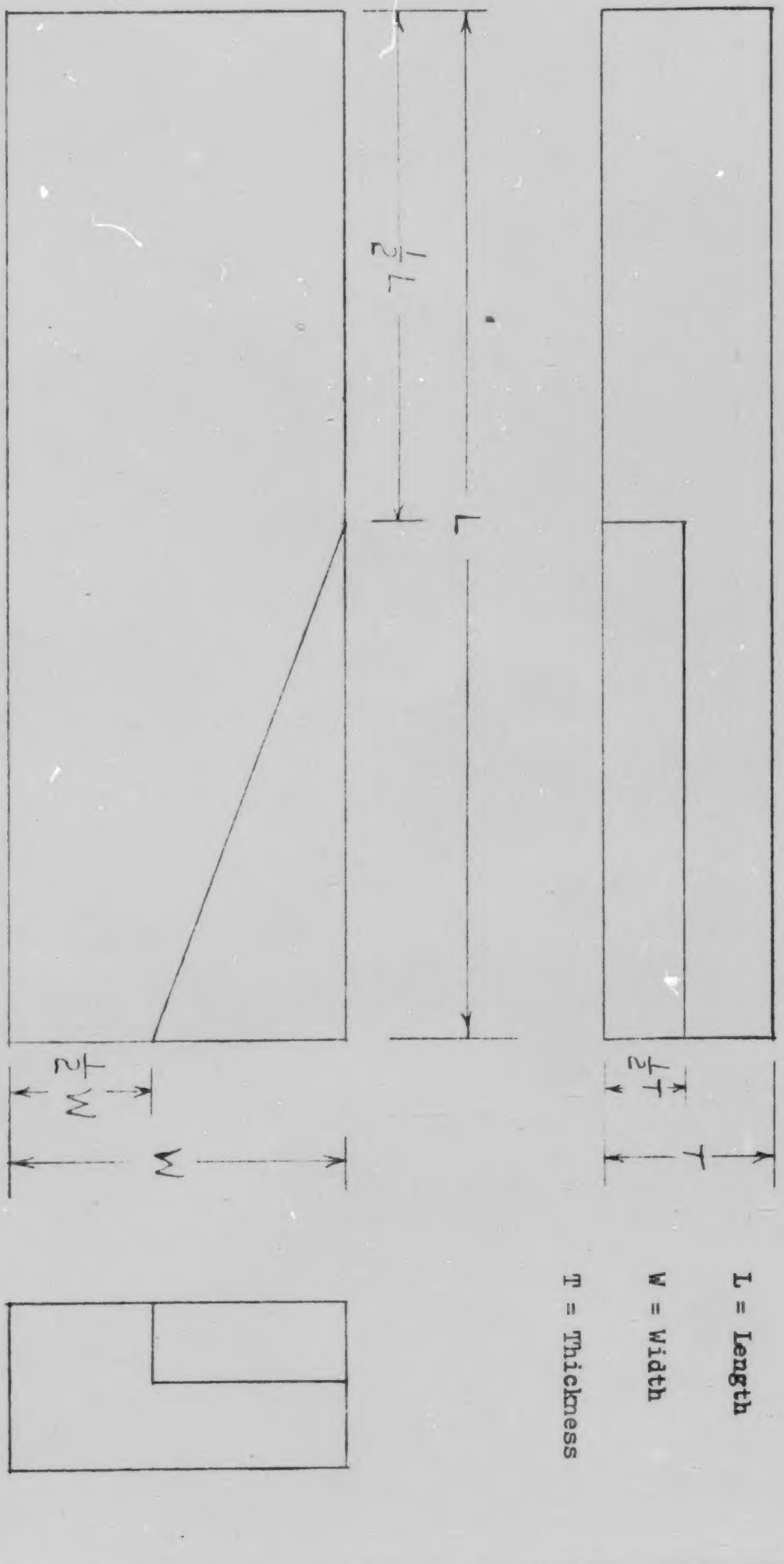
1. Using the drawing you have dimensioned, set up the milling machine to put a bevel on the workpiece.
2. Plan the operation.
3. Select the cutter and/or arbor.
4. Install holding device and clamp workpiece.
5. Determine the feed and speed.
6. Install cutter and/or arbor.
7. True the workpiece.
8. Have your instructor check your setup.
9. Mill a bevel that is 1/2 T and goes from 1/2 W to 1/2 L.
10. Check your work. Are the dimensions accurate?
11. Have your instructor check your work.
12. Remove your setup and clean the machine and area.
13. Replace all tools and cutters carefully.
14. Did you lubricate the machine before using?

LEARNING PRACTICE (cont'd):

Another job well done. Keep up the good work. You are really starting to get into the heart of milling operations. There's more to come, so prepare yourself for the next task package.

Just keep beveling along - and you'll wind up on a higher level in the machine-shop world.

BEVEL BLOCK



M-VII-10

UNIT VII: HORIZONTAL MILLING MACHINE OPERATIONS

TASK PACKAGE 10: INDEXING HEAD

PREREQUISITES: UNIT VII, TASK PACKAGE 9

RATIONALE:

You'll need a straight-thinking head on your shoulders in order to use the indexing head. It's a valuable tool for accuracy in cutting, and - would you believe it - you can put a square end on a round shaft with it.

You will sometimes see a round shaft with a square end, when you are working with tools or working around machinery. If you have ever wondered how these shafts were made, you will find out in this task package.

Putting a square end on a shaft may not seem like much of an operation, but to do this accurately requires the use of a device called the indexing head. The indexing head is an accessory that mounts on the milling machine table and allows the machinist to make evenly spaced cuts with complete accuracy. In effect, it is a device that helps the machinist divide a circle in almost any number of even parts. Because its function is to divide a circle, it is also called a dividing head.

The indexing head is not easy to employ and requires some hard and straight thinking to use. Are you the man for the job?

OBJECTIVE:

Upon completion of this task package you will be able to use the dividing or indexing head to mill flat surfaces on stock.

The standard of accuracy will be determined by the specifications of the drawing of the part.

LEARNING ACTIVITY:

1. View slide-sound programs M-VII-10 and M-VII-14A, an outstanding double feature.
2. Reference reading for this task package is:
   - a. Machine Shop Operations and Setups, pages 299 to 307. This is excellent information on the dividing or indexing head.
   - b. Machine Tool Technology, Unit 97, pages 367 to 370, and Unit 95, pages 350 to 364.
   - c. Review Mathematics for Vocations, packages 5 and 11.
3. Reference a, page 300, figure 25, shows a dividing head and footstock. List the labeled parts below:

a. e.

b. f.

c. g.

d. h.

LEARNING ACTIVITY (cont'd):

4. What are the three methods of indexing?

   a.

   b.

   c.

5. Study the reading material carefully so that you may ask questions about the indexing head.

6. Make a two-view drawing that shows three pieces of 8" stock, hexagon, octagon, and round, with one end squared for a distance of 1 1/2". The stock should be 1 inch in diameter and the square should be 1/2 inch.

7. Show your work to your instructor and start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Horizontal milling machine
2. Indexing head

1. Obtain from your instructor the following stock:

   a. 1-8" piece of round stock about 1 inch in diameter.

   b. 1-8" piece of hexagon stock about 1 inch in diameter.

   c. 1-8" piece of octagon stock about 1 inch in diameter.

LEARNING PRACTICE (cont'd):

2. If you have had Units IV or VI in this course, center drill the stock on each end. If you have not completed these units the instructor will give you stock that has been center drilled.
3. Select the cutter for the milling operation.
4. Install the indexing head on the milling machine.
5. Secure the workpiece in the indexing head.
6. You will use hand-feed for this operation, but set the speed.
7. True the workpiece.
8. Install the cutter.
9. Have the instructor check your setup and give a demonstration on using the indexing head.
10. Mill all three pieces of stock according to the specifications of your drawing.
11. Carefully check your work.
12. Have your instructor evaluate your work.
13. Clean up the machine and area.
14. Return all tools to their proper places.
15. Keep all stock for future use.

Using the indexing head makes many impossible jobs, possible. You will learn more about this device in a later task package.

If your work on this task package is any index, you have a good head for acquiring a machinist's craft skills.

M-VII-11

UNIT VII: HORIZONTAL MILLING MACHINE OPERATIONS

TASK PACKAGE 11: STRADDLE MILLING

PREREQUISITES: UNIT VII, TASK PACKAGE 10

RATIONALE:

Some politicians are said to straddle the fence on the issues. And maybe you, yourself, have straddled a fence in fun. But, have you ever done any straddle milling? No? Then here's your chance.

Using an indexing head on a milling machine increases its versatility by the addition of an accessory, but the milling machine is versatile in its own right. This you will see with the use of straddle milling in this task package.

Straddle milling is a popular milling technique employed in many cases to increase production in the machine shop. It is necessary for almost all machine shops to have the capability for producing large quantities of accurate parts, since this mass production is the "bread and butter" that keeps the machine shop in operation. You, as a machinist, should always be interested in your machine shop's producing the necessary quantities of good products, since this helps you keep your job. An out-of-work machinist is a poor machinist!

OBJECTIVE:

Upon completion of this task package you will be able to use the straddle mill technique to square and double-groove stock. An accuracy of ± .001 of an inch will be the acceptable performance.

LEARNING ACTIVITY:

1. View sound-slide program M-VII-11, starring Straddle Milling.
2. Reference reading for this task package is:
    a. Machine Shop Operations and Setups, pages 334 to 337. Note figures 24, 25, and 26.
    b. Machine Tool Technology, Unit 95, pages 359 to 363. This will be review reading.
    c. Blueprint Reading for Machinists. Note the drawing on page 14. The dimensions of this drawing are not important, but the shape of it is.
3. Using the part you beveled in task package 9 as a model, make a new drawing showing the bevel in the back and, on the right side, the front view. The bevel will now be shown as a hidden line. In the top view the bevel will be on the bottom, and also shown with a hidden line.

    NOTE: Place the part in the positions stated and this will help you with your drawing.

LEARNING ACTIVITY (cont'd):

4. On the drawing divide the new top surface into three parts, lengthwise. Show two grooves running lengthwise at a depth of 1/2 the thickness from the bevel to the top. Your drawing will look somewhat like the one in reference c, except yours will have a bevel shown with hidden lines.

   Note - Include the necessary dimensions in your drawing.

5. Show your drawing to your instructor and proceed to your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Horizontal milling machine
2. Cutters and arbor
3. Holding device
4. Layout tools
5. Dial indicator
6. Parallels

1. You will use the part you beveled in task package 9 and the drawing you made in the Learning Activity of this task package.
2. Select two cutters of equal diameter.
3. Clamp the part on the milling machine table.
4. Set the speed and feeds.
5. Install the cutters and arbor.
6. True the workpiece.
7. Have your instructor inspect your setup.
8. Straddle mill the grooves in the part as shown by the specifications

LEARNING PRACTICE (cont'd):

of your drawing. Your accuracy should be ± .001 of an inch.

9. Check your part carefully.
10. Have your instructor check the part.
11. Clean up the area and put away your tools.

Can you see how you can use the straddle mill technique to produce parts with great accuracy and with increased speed? The uses of this type of milling operation are unlimited for an intelligent machinist. Is this the kind of machinist you are?

You're really in the groove with this straddle milling.

M-VII-12

UNIT VII: HORIZONTAL MILLING MACHINE OPERATIONS

TASK PACKAGE 12: MILLING KEYWAYS

PREREQUISITES: UNIT VII, TASK PACKAGE 11

RATIONALE:

You are familiar with highways, byways, and expressways. And you may have been hot-rodding on the freeways. Well, now is the time to pause and consider the keyways.

Have you ever wondered what keeps wheels that are being turned by shafts from slipping? This task package will give you one of the answers to that question and will also show you how to machine shafts that won't slip.

A device called a key is one of the methods used to keep wheels from slipping on shafts. You will not learn to make keys in this package, but you will cut keyways in some shafts for the keys. The key is a small piece of metal that fits into the keyway and is usually purchased already made. There are times, however, when you as a machinist might make one. The keyway is an accurately machined groove in the shaft, and also in the wheel. Milling a keyway is another of the basic operations that is performed by the machinist and one that you will do many times. So learn this lesson well!

OBJECTIVE:

Upon completion of this task package you will be able to use end mill cutters and holding devices to mill keyways. An accuracy of ± .001 of an inch for both trueness and depth will be the acceptable performance.

LEARNING ACTIVITY:

1. View slide-sound program M-VIII-8, a keystone cops show.
2. Your reference material for this task package is:
   a. Machine Tool Technology, Unit 96, pages 364 to 368.
   b. Blueprint Reading for Machinists, Unit 21, pages 97 to 101, and Unit 12, pages 59 to 65.
3. Using the two-view drawing you made in task package 10 of the three pieces of stock, incorporate a Woodruff keyway, square keyway, and a third type of keyway (your instructor will tell you which type) in each shaft. You will also obtain from your instructor the dimensions for these keyways.
4. Your drawing will now show three pieces of stock with 9 keyways.

   NOTE: You may have to use the information in Unit 12 of reference b for your drawing.
5. Carefully go over your drawing with your instructor; he may have some suggestions on how to improve it. You should be ready now for your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Milling machine
2. Holding devices
3. Cutters and arbors
4. Layout tools
5. Measuring tools

1. Using the three pieces of 8" stock from task package 10 and the drawing you modified, cut three keyways in each piece of stock.
2. With the help of your instructor, select the cutters.
3. Secure the workpiece to the milling machine table.
4. Set the speed and feed if they are being used.
5. True the workpiece.
6. Install the cutter.
7. Mill the keyways.
8. Inspect your work carefully.
9. Have your instructor inspect your work.
10. Clean up the machine and area and put away the tools.

In this task package you milled keyways, but you can easily see that there are many more milling operations that can be performed using the basic setups of this task package.

A machinist's skills are the keyways to accomplishment and prosperity.

OBJECTIVE:

Upon completion of this task package you will be able to use end mills or other suitable cutters and holding devices to mill dovetails, T-slots, and angular cuts. The standard of accuracy will be determined by the specifications of the drawing.

LEARNING ACTIVITY:

1. View sound-slide program M-VIII-9, a three-star feature.
2. Read and study the following reference material:
   a. Machine Shop Operations and Setups, page 315, the topics T-slot Cutters and Dovetail Cutters. Note figures 10 and 11.
   b. Machine Tool Technology, pages 338 and 340, the topics Angular Milling Cutters and End Milling Cutters. Also, on pages 340 and 341, the topic T-slot Cutters.
3. Why are the teeth of a T-slot milling cutter staggered?

   ____________________ ____________________ ____________________
4. To mill a T-slot you would first cut a groove with an __________ mill cutter or a ______________ mill cutter.
5. There are two types of angular milling cutters. They are:

   a.__________________________ b. ________________________

   Note - The maximum depth of cut for end mills generally should not exceed 1/2 the diameter of the cutter. On hard, tough steel

LEARNING ACTIVITY (cont'd):

the maximum depth of cut should not exceed 1/4 the diameter of the cutter. On light-duty machines, the maximum depth of cut must be reduced further.

6. If you are cutting hard, tough steel on a heavy-duty milling machine with a 1/2" diameter cutter, your depth of cut should be ________________ of an inch.

7. Using the drawing of the part you made in a previous task package, modify this drawing to show an angular cut, a dovetail, and a T-slot.
    a. Secure from your instructor the sizes of the cutters listed above.
    b. Examine your drawing and your part carefully before you start your drawing.
    c. Draw in the three cuts you are going to make. You may make these cuts any place on the part that they will fit.
    d. Place the dimensions for these cuts on the drawing.
    e. Carefully think out the placement of these cuts and visualize how they will look on your part.

8. Show your work to your instructor. If he approves of it, go on to your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Horizontal milling machine
2. Cutters
3. Layout tools
4. Measuring tools

1. Using the drawing you modified in the Learning Activity, mill the part according to this drawing.
2. Select the cutters you will be using.
3. Plan the order of your cuts.
4. Clamp your part on the milling machine for the first cut.
5. Set the speed and feed.
6. True the workpiece.
7. Install the cutter
8. Have your instructor check the setup.

   Note - Did you lubricate the machine?
9. Mill the first cut.
10. Mill the other cuts. Find out if your instructor wants you to show him each of your setups before you start them. You may be advanced enough to do this on your own.
11. Your finished part should now have a bevel, grooves, T-slot, dovetail, and an angular cut. Does it?
12. Have your instructor check your part.
13. Clean up your area and machine. Carefully put away your tools.

LEARNING PRACTICE (cont'd):

You should now have a good idea of the basic uses of the milling machine. Don't forget that you are learning basic operations, and this means it is up to you to apply them when and where it is necessary.

It looks as if you slotted the angle and dovetail to a T!

M-VII-14

UNIT VII: HORIZONTAL MILLING MACHINE OPERATIONS

TASK PACKAGE 14: SPUR GEARS

PREREQUISITES: UNIT VII, TASK PACKAGE 13

RATIONALE:

Gear yourself up and make your spurs jingle-jangle for this package. If you're in the right gear and you spur yourself on, you will learn a lot about spur gears. Are you ready? Okay - shift your gears - but don't strip them!

You are about to start on the last operation on the horizontal milling machine. It is not only the last operation, but also the most complex of the ones you have done. It is, like the other operations, a basic one that you will be required to do as a machinist.

Cutting a spur gear with a standard involute gear cutter is the task you will do in this package. The word involute is defined as "a curve traced by a point on a thread kept taut as it is unwound from another curve." Does it seem strange to you to have a word defined as such involved in the machine shop? When you finish this task package, you will see how this word fits into the vocabulary of the machinist. Continue, now, by reading the Objective and doing the Learning Activity and the Learning Practice.

OBJECTIVE:

Upon completion of this task package you will be able to use a standard involute gear cutter to cut a spur gear from a blank. The specifications provided in Machine Shop Operations and Setups, pages 343 to 346, will be used to determine the correct choice of gear cutters. Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View slide-sound programs M-VII-14 and M-VII-14A, starring Spur Gear.
2. Your reference assignments for this task package are:
   a. Machine Shop Operations and Setups, pages 337 to 360.
   b. Machine Tool Technology, Unit 99, pages 372 to 382, and Unit 101, pages 383 to 386. Also review Unit 97, pages 367 to 370.
   c. Blueprint Reading for Machinists, Units 22 and 23, pages 101 to 115. This is a quick review of mathematics that you will be needing for this task package. If you still have math troubles, check the Mathematics for Vocations packages.
3. The reading assignment for this task package is a long one, but read and study it very carefully, as you will need to know

LEARNING ACTIVITY (cont'd):

this information to successfully complete the package.

4. Make a drawing of a quarter section of a gear. Use figure 11-137, page 377, of reference b as a guide. Your drawing should look like this illustration. Make sure you place on your drawing the information included in figure 11-137.
5. After you have finished your reading assignment and drawing, show your work to your instructor. If you have any questions about gears or gearing, now is a good time to ask them.
6. Start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Horizontal milling machine
2. Indexing head
3. Layout tools
4. Measuring tools

1. Obtain from your instructor a spur gear blank.
2. Using the gear blank as a guide and the reference material, determine the size of gear you will cut.
3. Select the gear cutter.
4. Set up the indexing head on the milling machine.
5. Install the gear blank.
6. Set the feed and speed.
7. True the gear blank.
8. Install the cutter.

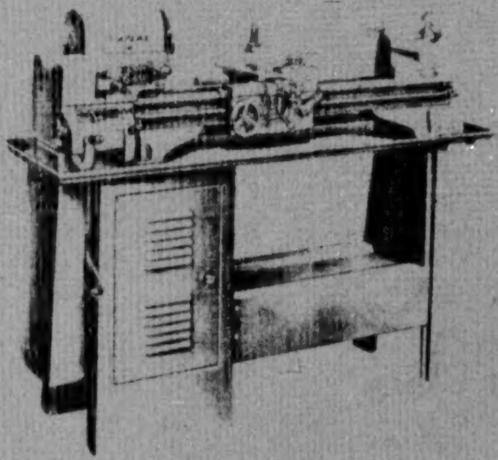
LEARNING PRACTICE (cont'd):

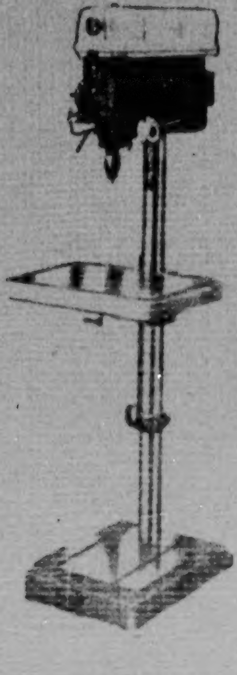
9. Have your instructor check your setup and he will demonstrate the gear cutting operation.
10. Mill the gear.
11. Have the instructor check the gear.
12. Clean up the machine and area. Carefully put away your tools and cutter. Always make sure you put a light coat of oil on all the exposed surfaces of the machine.

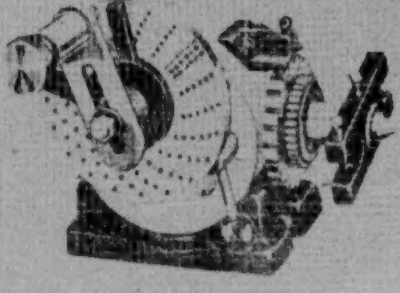
You have completed the operations on the horizontal milling machine. It's been a long series of task packages, but think back on what you have learned and you will be as pleased with your progress as your instructor is.

Now, shift gears and spur yourself on to additional machinist's skills.

RESEARCH PROJECT
SANFORD CENTRAL HIGH SCHOOL
1708 NASH STREET
SANFORD, NORTH CAROLINA 27330







CLUSTER: METALS

COURSE: MACHINE SHOP

CE003781 (1)

M-VIII

UNIT PACKAGE VIII: VERTICAL MILLING MACHINE OPERATION

PREREQUISITES: UNIT I

RATIONALE:

The true machinist is a craftsman who can do much more than turn the handles on a machine and make it cut metal. He is a man who is able to plan and think before acting. The machinist is also a man who is always learning and knows he will never learn all there is to know about the machine industry. The so-called machinist who thinks he knows it all, and never tries anything new, is really a man who is afraid of new ideas and machines. To be a real machinist you can never close your mind to what's new.

In this unit you will learn many new things that will require you to think, plan, and make decisions. You will be learning, not only about the vertical milling machines, but also related subjects that will help you become a real machinist and craftsman. You will have to work hard, but you will be rewarded in all the years ahead.

OBJECTIVES:

General:

Upon completion of this unit you will be able to perform machining operations on the vertical milling machine.

OBJECTIVES (cont'd):

Specific:

Upon completion of the task packages for this unit, you will be able to:

1. Select the proper cutter for vertical milling. Your performance will be evaluated in accordance with the instructor's checklist.
2. Use the necessary holding devices to clamp assorted workpieces on the milling machine in a secure manner. Your performance will be evaluated in accordance with the instructor's checklist.
3. Use the appropriate arbors, collets, holders, and/or adapters, to install and remove setups on the vertical milling machine. Your performance will be evaluated in accordance with the instructor's checklist.
4. Use a dial indicator to true the workpiece and/or holding device on a vertical milling machine. An accuracy of ± .0005 of an inch will be the acceptable standard of performance.
5. Set the proper feeds and speeds for the type of milling operation and material. Your performance will be evaluated in accordance with the instructor's checklist.
6. Use the proper cutting tools to drill, bore, and counterbore a workpiece. An accuracy of ± 1/64th of an inch will be the acceptable standard of performance.
7. Use end mills to square a workpiece. An accuracy of ± .001 of an inch will be the acceptable standard of performance.

OBJECTIVES (cont'd):

8. Use Woodruff keyseat cutters or end mills to mill keyways and dovetails. Acceptable performance will be an accuracy of ± .001 of an inch for depth and trueness.
9. Use swivel or universal vises and/or other holding devices to mill angles. The standard of accuracy will be determined by the specifications of the drawing.

LEARNING ACTIVITY:

Work the task packages in this unit in sequence. They have been designed to be worked this way so that it will be easier for you to learn to operate the vertical milling machine and also so you will be able to learn more in a shorter period of time.

While working on the task packages you may have a few problems or questions that you need help with. If you do, your Resource Center Director or instructor, will be glad to help you with these problems or questions.

In the packages you will be asked to view a sound-slide presentation, read and answer questions, and perform some practical exercises. The number and names of the task packages included in this unit are as follows:

TASK PACKAGE 1: SELECTION OF CUTTER

TASK PACKAGE 2: SECURING WORKPIECE

LEARNING ACTIVITY (cont'd):

TASK PACKAGE 3: INSTALLING CUTTERS

TASK PACKAGE 4: TRUING WORKPIECE

TASK PACKAGE 5: FEEDS AND SPEEDS

TASK PACKAGE 6: BORING AND COUNTERBORING

TASK PACKAGE 7: SQUARING

TASK PACKAGE 8: KEYWAYS AND DOVETAILS

TASK PACKAGE 9: MILLING ANGLES

If you have had experience with the vertical milling machine and feel you can do the above work, you may want to take the comprehensive test for this unit. Your instructor has the test, so talk it over with him and see if you should take it. If you don't take the test, start your work on the vertical milling machine with the first task package.

UNIT VIII: VERTICAL MILLING MACHINE OPERATIONS

TASK PACKAGE 1: SELECTION OF CUTTER

PREREQUISITES: UNIT I

RATIONALE:

Versatility was a characteristic of men during the Renaissance period from 1500 to 1750. Specialization seems to be the emphasis today. But, when it comes to versatility today, the milling machine has it.

In this task package you will be introduced to the milling machines and to the cutters they operate. You will find in studying about the milling machine that it is a very versatile machine that you will want to know about. You will also find that there are a number of attachments that can be combined with the milling machine to increase its versatility and give it an almost unlimited range of operations.

Coupled with the attachments are a wide selection of cutters to further increase the operations of the milling machine. You might be wondering how anyone can learn everything about a machine that has such a wide range of operations? The answer to that is that no person can know everything about this machine, but the more you know, the better machinist you will be.

Know your machines and you know you are a machinist.

OBJECTIVE:

Upon completion of this task package you will be able to select the proper cutter for vertical milling. Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View slide-sound programs M-VIII and M-VIII-1, both starring Millie Machine.
2. In your reference material read the following:
    a. Machine Shop Operations and Setups, pages 279 to 300, and pages 307 to 318.
    b. Machine Tool Technology, Units 87-89, pages 317 to 347.
    c. Blueprint Reading For Machinists, Units 6 to 11. If you have covered these units in other task packages, just review them for this one. You will need this inforamtion in future task packages in this unit.
3. List the ten end mills shown in figure 11-158 of reference b.

a. ______________________ f. ______________________

b. ______________________ g. ______________________

c. ______________________ h. ______________________

d. ______________________ i. ______________________

e. ______________________ j. ______________________

LEARNING ACTIVITY (cont'd):

4. After you have carefully studied the above material, inform your instructor. Then begin your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Milling cutters

1. Select the proper milling cutters to do the following jobs:
   a. bore a round hole.
   b. counterbore a hole.
   c. square stock.
   d. mill a Woodruff keyway.
   e. cut a dovetail.
2. After selecting the cutters, show your selections to your instructor and tell him the use of each cutter.
3. When you have completed the above, carefully return the cutters to their proper places.

You have been introduced to the milling machine and to its cutters. The information you have learned here will be used in later packages in this unit, so remember where you found it and refer to this information when you need it.

Be like the milling machine. Develop a versatility of your own.

M-VIII-2

UNIT VIII: VERTICAL MILLING MACHINE OPERATIONS

TASK PACKAGE 2: SECURING WORKPIECE

PREREQUISITES: UNIT VIII, TASK PACKAGE 1

RATIONALE:

"Safety first" is not just a cliche. In machine shop work you cannot overemphasize the factor of safety. If you think you can be a little careless, just consider the contents of this package.

There are some things you must learn before you actually start cutting or milling a workpiece on the milling machine. In the last task package you learned about the milling machine and also about the milling cutters. Now you will learn two very related subjects, securing the workpiece and safety. How are these subjects related? It doesn't take too much imagination to visualize what would happen if a workpiece became loose while you were milling it. Flying workpieces, striking fellow machinists, produce pools of blood and sometimes, in cases of near misses, they may come flying back to the careless machinist.

Donate your blood to the Red Cross, not to the machine shop floor.

OBJECTIVE:

Upon completion of this task package you will be able to use the necessary holding devices to clamp assorted workpieces on the milling machine in a secure manner. Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View sound-slide program M-VIII-2, held over for a long time.
2. Reference reading for this task package is:
   a. Machine Shop Operations and Setups, pages 296 to 300. Observe the manner in which workpieces are attached in the following figures and pages: (Gee, this requires no writing.)

Figure Number	Page Number
8	286
13 & 14	294
19	296
20 & 21	297
22 & 23	298
24	299
28	306
16	328
18	330

LEARNING ACTIVITY (cont'd):

Figure Number	Page Number
19	331
20 & 21	332
22	333
26	336
29	338

This is by no means a complete selection of the various ways in which workpieces can be mounted.

b. Machine Tool Technology, Unit 88, pages 328 to 334, shows some of the attachments used for holding the workpiece to the milling machine table. Other methods are shown in other units about the milling machine.

3. In reference a, page 360, there is a list of safety precautions. Write, in the spaces below, numbers 1, 2, and 6:

a.

b.

c.

4. Be sure you understand these safety rules. A good machinist is always a safe worker.

LEARNING ACTIVITY (cont'd):

5. See your instructor and show him your work. He may want to ask you some questions. Begin your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Vertical milling machine
2. Holding devices

1. Obtain from your instructor four workpieces.
   a. Have him mark the surfaces to be milled.
   b. Select one workpiece and secure it to the milling machine table.
   c. Have your instructor check your setup.
   d. Set up the other three workpieces and have your instructor check each one.
   e. Did you install all the workpieces properly? If so, you have done a good job.
2. Return all the holding devices to their proper places.
3. Clean the machine and area.
4. Put a light coat of oil on all machined surfaces. This is done to prevent rusting.

Securing workpieces on the milling machine table can be a complex job. A professional machinist is as careful of his setups as he is of his workmanship

UNIT VIII: VERTICAL MILLING MACHINE OPERATIONS

TASK PACKAGE 3: INSTALLING CUTTERS

PREREQUISITES: UNIT VIII, TASK PACKAGE 2

RATIONALE:

Here is an interesting and simple process with which the machinist must be familiar - the installation of cutters on the milling machine spindle. So don't let your mind go spinning off here, but focus it on the spindle.

In the first task package of this unit, you learned about the different milling machine cutters. Now, you will see how these cutters are installed on the milling machine spindle. While this is not a complicated process, it is, nevertheless, one that you must know if you are to succeed as a machinist.

Using the vertical milling machine will give you, as a machinist, many new skills; skills that will make you a valuable employee when the time comes for you to begin work in the machine shop. Use the time that you have now to acquire as much knowledge of this machine as you can.

Remember - knowledge can mean money.

OBJECTIVE:

Upon completion of this task package you will be able to use the appropriate arbors, collets, holders, and/or adapters, to install and remove setups on the vertical milling machine. Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View sound-slide program M-VIII-3, a real thriller.
2. To help you complete this task package, read the following references:
   a. Machine Shop Operations and Setups, pages 292 to 297 and pages 307 to 309.
   b. Machine Tool Technology, pages 343 to 346. Note figure 11-72.
   c. Blueprint Reading for Machinists, Units 11 and 12.
3. Older milling machines and certain small, vertical milling machines are equipped with a spindle nose which has a self-holding taper; this is usually a ________________ and ________________ taper.
4. The collet adapter is used for mounting end mills on the ________________.
5. If a self-holding arbor does not release when a normal force is

LEARNING ACTIVITY (cont'd):

applied to the arbor bolt with a wrench, you should ____________

____________ ____________.

6. Page 360 of reference a contains some safety precautions. In the spaces below write numbers 3, 4, and 5:

   a.

   b.

   c.

When you have finished the above work, show the results to your instructor. You may then proceed to your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Vertical milling machine
2. Holding devices

1. Your instructor will give you several kinds of milling cutters for the vertical milling machine.
   a. Select the appropriate holding device for each cutter.
   b. Install the device in the milling machine.
   c. Secure the cutter in the holding device.
   d. Have your instructor check your setup.
   e. Install each cutter in turn with its proper holding device.

LEARNING PRACTICE (cont'd):

f. Have your instructor check each setup.

g. When your instructor approves all of your setups, carefully put away all the cutters and holding devices. Don't forget to oil the machined surfaces.

2. Note the many different arrangements that are used for holding the cutters in the milling machine.

All of the task packages you have completed so far are steps leading to the actual running of the vertical milling machine. In a couple more steps you will be ready to run this machine.

Climb 'til your dreams come true.

UNIT VIII: VERTICAL MILLING MACHINE OPERATIONS

TASK PACKAGE 4: TRUING WORKPIECE

PREREQUISITES: UNIT VIII, TASK PACKAGE 3

RATIONALE:

If you're going to be true to your work, you will have to true your workpiece. This process is another steppingstone by which you become a proficient machinist. It takes perseverance to pursue your goal in acquiring craft skills.

Learning to operate a machine by using a step-by-step process, as you are doing with these task packages, requires the new machinist to have a lot of patience. At this point, you want to put a workpiece on the vertical mill and start making some metal chips fly, but there are a couple more lessons that must be learned before you do your first operation.

In this task package you will learn the importance of truing the holding device and/or the workpiece. Too often, many new machinists assume that, since the machine is built with great accuracy, the work produced will also be very accurate. However, the finished workpiece can only be accurate if it is installed on the machine in an accurate manner. Installing your work accurately is what you will be learning in this task package.

The price of inaccurate work can be no work!

OBJECTIVE:

Upon completion of this task package you will be able to use a dial indicator to true the workpiece and/or holding device on a vertical milling machine. An accuracy of ± .0005 of an inch will be the acceptable standard of performance.

LEARNING ACTIVITY:

1. View sound-slide program M-VIII-4, a true-blue thriller.
2. Complete the following assignments for this task package:
   a. Machine Shop Operations and Setups, pages 328 and 329, the topic Mounting Workpiece and Cutter. Notice figure 17 on page 329.
   b. Machine Tool Technology, Unit 91, pages 351 to 355 figure 11-90 on page 352.
   c. Blueprint Reading for Machinists, Units 14 and 21.
3. While you are working on this task package you may find it's a good time to check your mathematics skills. If so, try some of the pretests in the Mathematics for Vocations packages.
4. When you have finished the above, start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Vertical milling machine	4. Parallels
2. Holding device	5. Solid steel square
3. Dial indicator	

1. Obtain from your instructor two workpieces. He will show you where these are to be milled.
   a. Install a vise on the milling machine and, using the dial indicator, true the stationary jaw parallel to the length of the milling machine table.
   b. Have your instructor check your work. You must be accurate to ± .0005 of an inch.
   c. Rotate the vise 90° and true it again.
   d. Are you accurate to ± .0005? If so, have your instructor check your work.
   e. Now secure the workpieces in the holding device, one at a time. True them in all directions, and have your instructor check each one.
2. When you have completed the above, return the workpieces to the instructor, clean the machine, oil the exposed surfaces, and put away the holding devices.

LEARNING PRACTICE (cont'd):

Hopefully, you can see how necessary it is to true your work before you start any milling operation. Accurate work is the hallmark of the professional machinist.

You've trued your workpiece - now true your dream of becoming a skilled machinist.

UNIT VIII: VERTICAL MILLING MACHINE OPERATIONS

TASK PACKAGE 5: FEEDS AND SPEEDS

PREREQUISITES: UNIT VIII, TASK PACKAGE 4

RATIONALE:

Proper speed is important in feeding. You know this from your experience at the dining table. If you don't feed yourself at the proper speed, you notice the effects of it. It's the same in machining. It doesn't pay to do the work without proper coordination of speeds and feeds.

This task package is important from the standpoint of your personal safety and the efficient use of the milling machine. It also concerns the finished product that you will produce on the milling machine.

You will learn here how to set the feed and speed on the machine in order to mill a finer product. Remember - every skilled machinist takes pride in the end results of his work.

OBJECTIVE:

Upon completion of this task package you will be able to set the proper feeds and speeds for the type of milling operation and material. Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View sound-slide program M-VIII-5, starring Speedy Feeder.
2. To help you complete this task package, read the following reference materials:
    a. Machine Shop Operations and Setups, pages 322 to 328. Also tables XIV, XV, XVI and XVII on pages 506, 507, 508 and 509.
    b. Machine Tool Technology, Unit 90, pages 347 to 352.
    c. Blueprint Reading for Machinists, Unit 20, pages 93 to 97.
3. The circumferential speed of the milling cutter is called the

    ______________________ ____________________________

4. What is the meaning of:
    a. (rpm)
    b. (sfpm)
5. The ease with which metal can be cut is called ______________

LEARNING ACTIVITY (cont'd):

6. Calculate the approximate rpm for a 1" diameter end mill which is to mill annealed, high-carbon steel at 60 sfpm.

7. Determine the speed and feed for the following material. Use tables 10 and 11 on pages 348 and 349 in reference b. Don't forget to read the fine print at the bottom of these tables.

MATERIAL	CUTTING SPEED	CUTTER TYPE	FEED	TYPE OF CUT
a. Low-carbon steel	________	End Mill	________	Roughing (HD)
b. Low-carbon steel	________	End Mill	________	Finishing
c. Cast iron, medium	________	End Mill	________	Roughing (HD)
d. Cast iron, medium	________	End Mill	________	Finishing
e. Aluminum	________	End Mill	________	Roughing (HD)
f. Aluminum	________	End Mill	________	Finishing

Note: Use the midpoint of the cutting-speed range for the cutting speed.

8. Show your work to your instructor and begin your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Vertical milling machine

1. Using tables 10 and 11 as your guide, set the speeds and feeds for the following materials:

Note: Do not turn on the machine until your instructor tells you to.

LEARNING PRACTICE (cont'd):

MATERIAL	SPEED	FEED
a. Low-carbon steel	____________	____________
b. Medium-carbon steel	____________	____________
c. High-carbon steel, annealed	____________	____________
d. Stainless steel	____________	____________
e. Cast iron, soft	____________	____________
f. Cast iron, medium	____________	____________
g. Malleable iron	____________	____________
h. Brass	____________	____________
i. Aluminum	____________	____________

2. Set the speed and feed for each material, have your instructor check your settings, and turn on the machine and observe what is happening.

3. Remember that different materials require different speeds and feeds.

   Don't be a lazy machinist; set the proper speed and feed for the type of material, cutter and operation.

   Now you're really feeding your mind with knowledge of the machinist's skills.

UNIT VIII: VERTICAL MILLING MACHINE OPERATIONS

TASK PACKAGE 6: BORING AND COUNTERBORING

PREREQUISITES: UNIT VIII, TASK PACKAGE 5

RATIONALE:

You've heard of boring, haven't you? That's the process of making people yawn. If this is true, then counterboring must be the method of counteracting yawns. In this package, however, you will look at different types of boring and counterboring.

You probably won't believe this, but you will do a milling operation in this task package. It has been a long road up to this point and you have taken it step by step, but you have now arrived.

The milling operation you will do in this task package will consist of drilling holes in a workpiece and then counterboring these holes. These are operations that are performed on the vertical milling machine when a greater degree of accuracy is needed than can be obtained by doing these same operations on a drill press.

Another operation you will perform in this task package is that of boring a large hole in the workpiece. Again, the matter of accuracy is the deciding factor for choosing to do this operation on the vertical milling machine.

OBJECTIVE:

Upon completion of this task package you will be able to use the proper cutting tools to drill, bore, and counterbore a workpiece. An accuracy of ± 1/64th of an inch will be the acceptable standard of performance.

LEARNING ACTIVITY:

1. View slide-sound programs M-IV and M-VIII-6, which are not boring shows.
2. Read and study the following reference materials:
   a. Machine Shop Operations and Setups, pages 317 to 330. This is review reading.
   b. Machine Tool Technology, Unit 40, pages 185 to 194.
   c. Blueprint Reading for Machinists, Units 22 and 23. This is an excellent review of mathematics. If you need additional help with your math skills, check the Mathematics for Vocations packages.
3. On the drawing in this task package add the following items:
   a. Show the location of four drilled holes, one at each corner and 1/2" in from each edge. The size of these holes will be determined in the Learning Practice.
   b. Show the location of a hole in the center of the piece. The size of this hole will be 1.125" in diameter.

LEARNING ACTIVITY (cont'd):

4. After you have completed the drawing, show it to your instructor. He will tell you if you are ready to begin the milling operation.

LEARNING PRACTICE:

Tools and Equipment

1. Vertical milling machine
2. Holding device
3. Drill bits
4. Counterbore
5. Boring tool
6. Layout tools
7. Measuring tools

1. Obtain from your instructor a piece of stock about 6" in length, 2" in width, and 1" thick.
2. Using the drawing you modified in the Learning Activity, lay out the locations of the holes to be drilled. Your instructor will give you the diameter of these holes and also the diameter of the counterbore.
3. Lay out the location of the center hole that will be bored.
4. Add these sizes to your drawing and also show the holes on all three views of the drawing.
5. Drill and counterbore the four corner holes and bore the center hole.

   NOTE: Lubricate the machine.

   a. Select the drill bit and counterbore.
   b. Secure the workpiece in the holding device.

LEARNING PRACTICE (cont'd):

c. True the workpiece.

d. Set the speed and feed.

e. Install the cutting tool.

f. Have your instructor check your setup.

g. Do the machining operation.

h. Inspect your workpiece for workmanship and accuracy.

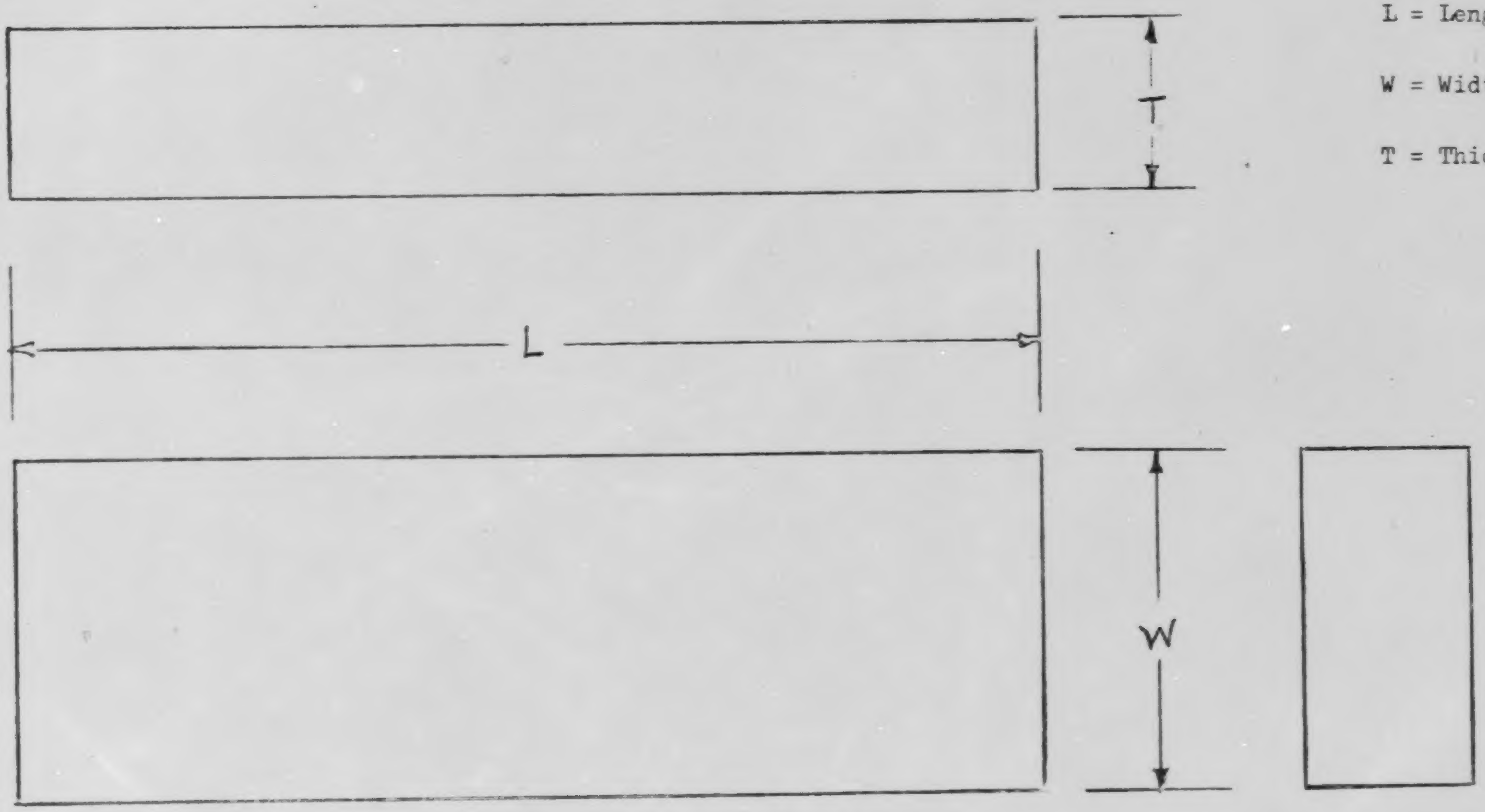
i. Have your instructor inspect your work.

6. Clean up the machine and area, return the tools and holding device to their proper places, and put a light coat of oil on the machined surfaces.

7. Save the workpiece and drawing for future use.

Now that you have completed your milling operation, you should be able to understand why you used the step-by-step approach to learning the operations of this machine. Good building is done on strong foundations. You now have a strong foundation.

Remember - the hills are never as steep as they seem.



L = Length

W = Width

T = Thickness

UNIT VIII: VERTICAL MILLING MACHINE OPERATIONS

TASK PACKAGE 7: SQUARING

PREREQUISITES: UNIT VIII, TASK PACKAGE 6

RATIONALE:

Have you ever heard mathematicians discuss the squaring of the circle? Well, you won't be doing that here, but you will be squaring a part. And you don't have to be a "square" to do it.

In the last task package you took a piece of rough stock and made some holes in it. This piece of stock has now become a part, but it still does not have a machined look about it. It seems a little rough to you and maybe just a hunk of metal with holes in it.

To give your part an overall machined look, it is necessary to square it; that is, to make the sides and surfaces true to each other. Once this has been accomplished, the workpiece, or your part, can now be machined with great accuracy.

In this task package you will learn how to square a part on the vertical milling machine.

An accurate machinist is an employed machinist!

OBJECTIVE:

Upon completion of this task package you will be able to use end mills to square a workpiece. An accuracy of ± .001 of an inch will be the acceptable standard of performance.

LEARNING ACTIVITY:

1. View sound-slide program M-VIII-7, starring Fred Squaring.
2. Reference reading for this task package is:
    a. Machine Shop Operations and Setups, pages 331 to 333.
    b. Machine Tool Technology, Unit 92, pages 355 to 357.
    c. Blueprint Reading for Machinists, Units 22 and 23 if you are having any math problems.
3. In reference a, there are some safety precautions. Write numbers 7 and 8 in the spaces below.

    a. ______________________________

    ____

    b. ______________________________

    ____

4. End milling cutters have teeth on the periphery as well as on the end __________.

LEARNING ACTIVITY (cont'd):

5. In reference a, page 331, figure 19, an end mill is shown. What kind of end mill is it? ____________ __________________.
6. Figures 20 and 21 in reference a show two milling operations. Are these end milling operations? ____________________________
7. The setups shown in reference b, Unit 92, are of a horizontal milling machine, but the procedure for the vertical milling machine will be the same. As a machinist you must be able to adapt procedures from one machine to another.
8. Do you have any questions about how you are to proceed with squaring a piece of stock on the vertical milling machine? If so, ask your instructor and also show him the work you have done in the Learning Activity. You should be ready to go on to your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Vertical milling machine
2. Holding device
3. Milling cutters
4. Measuring tools
5. Solid square
6. Dial indicator

1. Using the piece you made in task package 6, square the ends and flat surfaces. An accuracy of ± .001 of an inch is the acceptable standard of performance.

NOTE: Lubricate the machine.

LEARNING PRACTICE (cont'd):

a. Select the cutters to be used.

b. Select and secure the holding device to the milling machine table.

c. Install the workpiece in the holding device.

d. True the workpiece using the dial indicator.

e. Install the cutter.

f. Have your instructor check your setup.

g. Mill the ends and surfaces of the workpiece.

h. Check your part for accuracy.

i. Have your instructor check your part.

j. If you have been successful, clean the machine and area, put away your tools and equipment, and apply a light coat of oil on the machined surfaces of the mill.

2. On the drawing you modified in task package 6 enter the dimensions of your part as it now is.

3. Save your part and your drawing for future use.

Squaring stock takes a sharp machinist and a smart machinist. Keep up the good work!

You're definitely squared away for continuing to advance toward new machinist's skills.

UNIT VIII: VERTICAL MILLING MACHINE OPERATIONS

TASK PACKAGE 8: KEYWAYS AND DOVETAILS

PREREQUISITES: UNIT VIII, TASK PACKAGE 7

RATIONALE:

Vertical and versatile - these two V-words describe the vertical milling machine. It serves many purposes, and in this package you will become familiar with two new uses of it. So get keyed way up and dovetail into this package.

The vertical milling machine is a very versatile machine. Like most machines in the shop, it is called on to do many different operations. How many operations a machine can perform is limited by the ability of the machinist more than by the machine itself. This is a fact of life for the machinist and one that is understood by the employer of machinists. There will be very few times when you as a machinist can honestly say that a job can't be done because it's beyond the ability of the machine.

In this task package you will learn two new operations on the vertical milling machine. These operations are the milling of keyways and dovetails. Both are basic, but important, skills that you will need to know in the future.

The skilled machinist is in command of his machine; the unskilled machinist is a slave to his machine!

OBJECTIVE:

Upon completion of this task package you will be able to use Woodruff keyseat cutters or end mills to mill keyways and dovetails. Acceptable performance will be an accuracy of ± .001 of an inch for depth and trueness.

LEARNING ACTIVITY:

1. View slide-sound programs M-VIII-8 and M-VIII-9, a keyway production.
2. To aid you in completing this task package, read the following reference material:
    - a. *Machine Shop Operations and Setups*, page 312, the topic End Mills, and page 315, the topics Dovetail Cutters and Woodruff Keyseat Cutters.
    - b. *Machine Tool Technology*, Unit 96, pages 364 to 368.
    - c. *Blueprint Reading for Machinists*, page 98. This is a drawing of a part with a keyseat in it. You will someday be working from this type of drawing.
    - d. *Metalwork Technology and Practice*, section 1284, pages 555 to 559. This is a review of vertical milling machine operations. Note figure 1223 on page 558 and the other pictures on the following pages.

LEARNING ACTIVITY (cont'd):

3. Make a two-view drawing (see Unit 6 of reference c, if you are unsure of what a two-view drawing is) of a shaft that is 8" in length and has a diameter of 1". Show three different keyways on this shift. Ask your instructor about the types and sizes of these keyways.
4. Modify the drawing you used in the last task package to show a dovetail running the length of the part, on the top and parallel to the edges, and in the center of the workpiece. Show the dovetail on all three views. Ask your instructor for the size of the dovetail.
5. When you have completed these drawings, show the work to your instructor and proceed to the Learning Practice.

LEARNING PRACTICE:

Tools and Equipment:

1. Vertical milling machine
2. Holding devices
3. Cutters
4. Measuring tools
5. Layout tools
6. Dial indicator

1. Obtain from your instructor a piece of round stock about 1" in diameter and 8" in length. Mill three different keyways in this stock using the drawing you made in the Learning Activity as a guide.
   a. Lubricate your machine.

LEARNING PRACTICE (cont'd):

   b. Select the cutters.

   c. Secure the holding device to the milling machine table.

   d. Insert the workpiece in the holding device.

   e. True the workpiece.

   f. Set the feed and speed.

   g. Install the cutter.

   h. Have your instructor check the setup.

   i. Mill the keyways.

   j. Check the keyways for trueness of depth and alignment.

   k. Have your instructor check your work.

2. Mill a dovetail in your machined part. Use the drawing you modified in the Learning Activity as your guide.

   a. Select the dovetail cutter.

   b. Secure the holding device to the milling machine table.

   c. Insert the part in the holding device.

   d. True the part.

   e. Set the feed and speed.

   f. Install the dovetail cutter.

   g. Have your instructor check the setup.

   h. Mill the dovetail.

   i. Inspect your work accuracy.

   j. Have your instructor check your work.

LEARNING PRACTICE (cont'd):

k. Clean up the machine area, return your cutters and tools, and put a light coat of oil on the machine surfaces of the milling machine.

Examine the work you have done. If you get a feeling of pride from this work, you have the makings of a good craftsman and machinist in you. The good machinist always takes pride in his work.

It looks as if the machine shop is the keyway to an exciting career for you.

UNIT VIII: VERTICAL MILLING MACHINE OPERATIONS

TASK PACKAGE 9: MILLING ANGLES

PREREQUISITES: UNIT VIII, TASK PACKAGE 8

RATIONALE:

Everywhere people are concerned with the angles. So is the machinist - in his own way. Pause here and acquire the necessary skill of milling angles.

There are two operations that you will be doing in this task package and they are milling a bevel and making an angular cut. Because there is such a slight difference between the bevel and the angular cut, both have been included in this package.

A bevel is defined as "the angle that one surface or line makes with another when they are not at right angles." In the machine trade the bevel is usually the removing of a small amount of material around the edges of a piece. The angular cut, on the other hand, may be made anywhere on a workpiece, and it usually means machining more material than when making a bevel. In either case you will be milling at an angle, and this is why both operations are included in this package.

OBJECTIVE:

Upon completion of this task package you will be able to use swivel or universal vises and/or other holding devices to mill angles. The standard of accuracy will be determined by the specifications of the drawing.

LEARNING ACTIVITY:

1. View slide-sound program M-VIII-10, featuring Millie Angle.
2. The reading assignments for this task package are:
   a. Machine Shop Operations and Setups, pages 316 and 317, the topic Angle Milling Cutters. Note figure 12, page 315. Also notice figure 21, page 332.
   b. Machine Tool Technology, pages 338 and 339 and figures 11-56 and 11-57. Also read Unit 94, pages 358 and 359.
3. On the drawing you have been using of your part in the last task package, make the following modifications:
   a. Draw a bevel on the top of the part, parallel to the dovetail, from a point tangent to the counterbored holes to a depth of 1/2 the thickness of the part.

NOTE: The surface with the dovetail will be considered the top of the part.

LEARNING ACTIVITY (cont'd):

b. Show on the bottom of your drawing (see Unit 4, page 21, of Blueprint Reading for Machinists if you have trouble with invisible lines) an angular cut that is perpendicular to the length of the part and extends from the top surface edge to a distance equal to the thickness of the part. This angular cut will be shown on both ends of the part and on all three views of the drawing. Your drawing should now show seven holes, one dovetail, two bevels, and two angular cuts. Does it? You may need to get help on this from your instructor or perhaps the drafting instructor.

4. When you complete the drawing you will be ready for your Learning Practice. Make sure your instructor has checked the drawing.

LEARNING PRACTICE:

Tools and Equipment

1. Vertical milling machine
2. Holding device
3. Milling cutters
4. Layout tools
5. Measuring tools
6. Dial indicator

1. Using the drawing you have modified and your machined part, bevel the machined part.
   a. Lubricate the milling machine.
   b. Select the cutters for the bevels.

LEARNING PRACTICE (cont'd):

c. Secure the holding device to the milling machine table.

d. Install the workpiece in the holding device.

e. True the workpiece.

f. Install the cutter.

g. Have your instructor check the setup.

h. Mill the bevels.

i. Check the bevels for accuracy, using your drawing as a guide.

j. Have your instructor check your work.

2. Using the drawing specifications, make the two angular cuts on the machined part.

a. Follow the above procedure.

b. When the job is completed, and your instructor has approved it, clean the machine and area, put away tools and cutters, and oil the machined surfaces of the milling machine.

While this is the last operation on the vertical milling machine in this unit, it is by no means all of the operations you will be called on to perform with this machine. Keep your eyes open as you work in the machine shop, and you will learn many more ways of using the vertical mill.

You're milling the right angles for an exciting career in metals.

RESEARCH PROJECT
SANFORD CENTRAL HIGH SCHOOL
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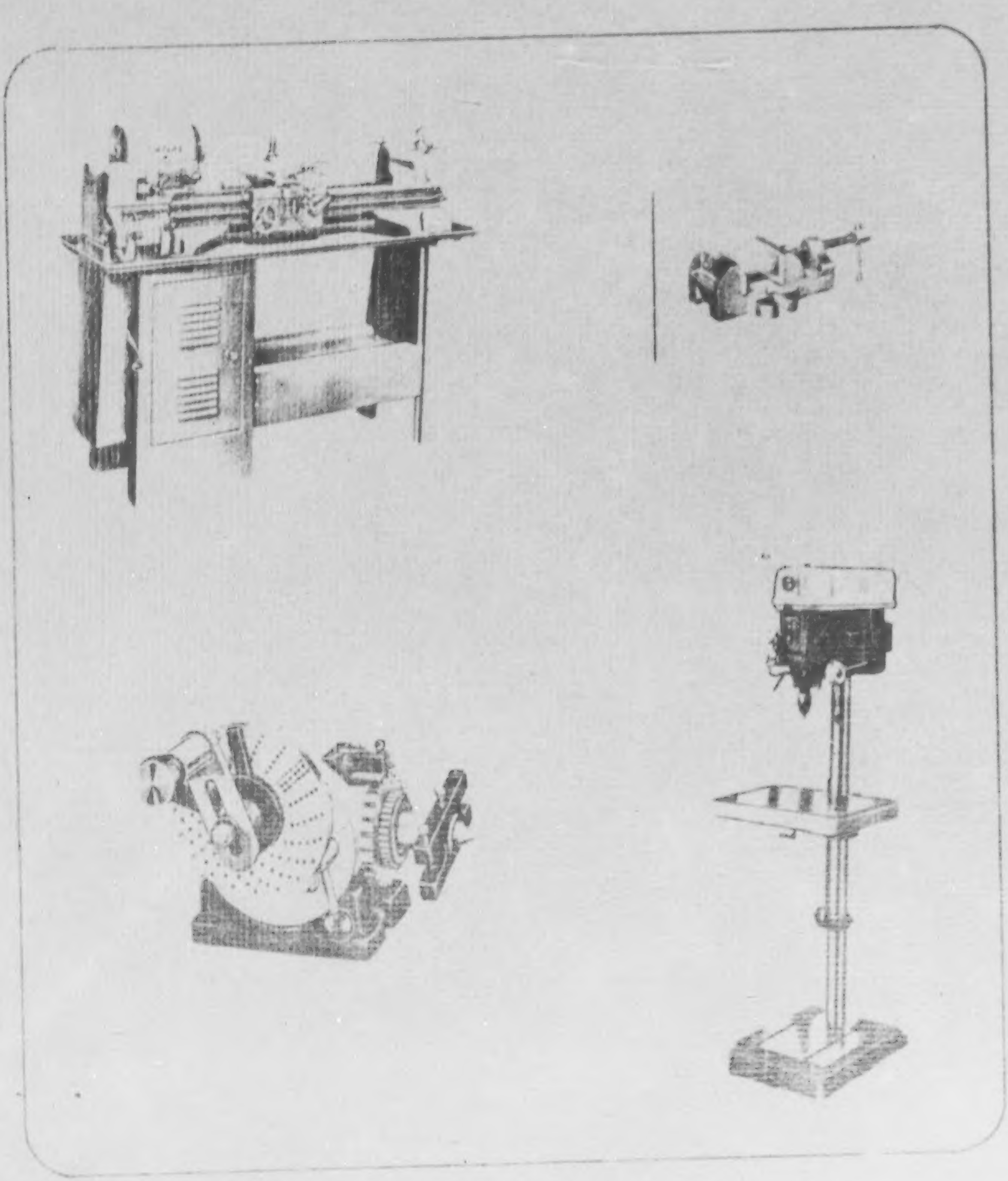
SANFORD, NORTH CAROLINA 27330



CLUSTER: METALS

COURSE: MACHINE SHOP

CE003793/(CJ)

M-IX

UNIT IX: SURFACE GRINDER OPERATIONS

PREREQUISITES: UNIT I

RATIONALE:

Removing material by using a grinding wheel is a very old art. In the early colonial days, most farmers had some kind of grinding wheel to keep their tools sharp. Even today a small electric grinder is a common tool in the home workshop.

In this unit you will learn to operate a grinder that is somewhat different from the ones used to sharpen farm and home tools. The machine you will learn about is a surface grinder, a machine that is used to grind flat surfaces on workpieces.

Besides learning about the surface grinder, you will also learn about grinding or abrasive wheels; you will see, from your reference reading, that the manufacture of abrasive wheels requires a great deal of technology and is no simple science. Also you will find out that the grinding operations are important to the machine trades.

OBJECTIVE:

GENERAL:

Upon completion of this unit you will be able to grind workpieces on the surface grinder.

OBJECTIVE (cont'd):

SPECIFIC:

Upon completion of the task packages for this unit, you will be able to:

1. Select and change grinding wheels, meeting the requirements of material to be ground. Your performance will be evaluated in accordance with the instructor's checklist.
2. Use the diamond tip dresser to dress the grinding wheel to a true shape in relationship to the magnetic chuck or work table surface. Your performance will be evaluated in accordance with the instructor's checklist.
3. Perform the following:
    a. position and secure the workpiece on the magnetic chuck.
    b. align the workpiece surface parallel to the face of the grinding wheel to an accuracy of ± .001 of an inch, using the dial indicator.

    Your performance will be evaluated in accordance with the instructor's checklist.
4. Grind workpieces. The standard of accuracy will be determined by the specifications of the drawing.

LEARNING ACTIVITY:

To help you in learning about the surface grinder, the task packages in this unit have been designed to be worked in sequence. Task package 1 will introduce you to the surface grinder and to grinding wheels. The other task packages will take you, step by step, through the material until you learn to operate the surface grinder.

You may experience some problems as you study these task packages, or you may want to know more about the information presented; if so, you may ask your Resource Center Director, or instructor, and he will gladly help you.

In the task packages in this unit you will be asked to view a sound-slide presentation, read and answer questions, and perform some practical exercises. The number and names of the task packages included in this unit are as follows:

TASK PACKAGE 1: ABRASIVE WHEEL

TASK PACKAGE 2: DRESSING WHEELS

TASK PACKAGE 3: TRUING WORKPIECE

TASK PACKAGE 4: GRINDING WORKPIECE

If you feel, after reading the above material, that you can successfully perform all the Specific Objectives, you may see your instructor about taking the comprehensive unit test. If you don't have the experience or knowledge to take the test, then start with the first task package and learn about the surface grinder. You should enjoy working with this machine.

UNIT IX: SURFACE GRINDER OPERATION

TASK PACKAGE 1: ABRASIVE WHEELS

PREREQUISITES: UNIT I

RATIONALE:

Keep the wheels turning as you enter a new unit by way of this package. You're wheeling on to new machinist's skills.

The starting of a new unit usually requires that you learn some background material along with the material needed to complete the task package. This unit is no exception, but the background information that you learn about may surprise you somewhat. As an example, most new machinists who have worked on lathes, milling machines, or shapers feel that these machines are extremely accurate. You will find from the reading reference, however, that to do a really accurate job on a workpiece, the workpiece is mounted on one of the various types of grinders for the finishing operation. The grinder can easily do work to a tolerance of one-ten-thousandth of an inch and some grinders are much more accurate than this. That is cutting things mighty close!

In this task package you will learn to change the wheel on the surface grinder. This is an important job that must be done properly, as your safety is involved.

OBJECTIVE:

Upon completion of this task package you will be able to select and change grinding wheels, meeting the requirements of the material to be ground. Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View slide-sound program M-IX-1, featuring Sir Abrasive Wheel.
2. Reference reading for this task package will be:
   a. Machine Shop Operations and Setups, pages 361 to 363 and pages 393 to 398.
   b. Machine Tool Technology, Units 113, 115, and 116.
   c. Blueprint Reading for Machinists, Units 6 to 11, pages 33 to 55.
   d. Mathematics for Vocations, reviewing any of these math packages that you may feel weak in.
3. Take a walk to the machine shop and find the surface grinder. Is it a vertical or horizontal spindle grinder? ________________
4. Now that you have seen the surface grinder, it's time to do some work with it. Proceed to your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Surface grinder
2. Grinding wheels
3. Necessary tools

1. Change grinding wheels on the surface grinder for grinding steel bars.
   a. Locate the grinding wheels.
   b. Select the wheel to be used. Refer to your reference material for help in making the selection. You may also need help from your instructor.
   c. Inspect the wheel - use the "ring test" and visual inspection. Also see Information Sheet 1 in this task package for information on the ring test.
   d. Examine the wheelhead and select the tools you will need for the job.
   e. Explain to your instructor the procedure for changing the wheel.
   f. Change the wheel.
   g. Have your instructor check your work.
   h. Change the wheel again and repeat the procedure, except for step e.
   i. Have your instructor check your work.
   j. Store the remaining wheel in its proper place and clean up the machine and area.

LEARNING PRACTICE (cont'd):

Changing grinding wheels seem like a small task to you? If it does, don't underrate its importance. This is a job that must be done properly, as your safety is involved.

It appears that you're going to become a real wheel as a machinist.

INFORMATION SHEET 1

Wheels must be dry and free from sawdust when applying the ring test, otherwise the sound will be deadened. It should also be noted that organic bonded wheels do not emit the same clear metallic ring as do vitrified and silicate wheels.

Illustration 1

Illustration 2

"Tap" wheels about 45 degrees each side of the vertical center line and about 1 or 2 inches from the periphery as indicated by the spots in Illustrations 1 and 2.

Then rotate the wheel 45 degrees and repeat the test.

A sound and undamaged wheel will give a clear metallic tone. If cracked, there will be a dead sound and not a clear "ring."

"Ring Test"

If the whdel is not too heavy it may be suspended from the hole on a small pin or the finger. (See Illustration No. 3). Heavier wheels may be allowed to rest in a vertical position on a clean hard floor.

Illustration No. 3

INFORMATION SHEET 1 (cont'd)

"Tap" the wheel gently with a non-metallic implement such as a wooden screw driver handle for light wheels and a wooden mallet for heavy wheels. The best spot to "tap" a wheel for the ring test is about 45 degrees either side of the vertical center line and about 1 or 2 inches from the periphery.

If struck directly along the vertical center line, the "ring", even in a sound wheel, is sometimes muffled and may give the erroneous impression that the wheel is cracked. This is especially true with large wheels which are supported on the floor when conducting this test. (See Illustration 2). It is sometimes noticeable also when the wheel is suspended from the hole. It is recommended that the test be repeated after rotating the wheel 45 degrees to the right or left.

Repeat this "ring test" immediately before mounting either a new or used wheel on a machine especially if the wheel has been in storage or out of service for a considerable time. In making this test it must be realized that wheels bonded with organic material do not give forth the same clear metallic sound as do vitrified and silicate wheels. Also wheels must be dry and free from sawdust when applying the test, otherwise the sound will be deadened.

Comparison of the sound with other wheels of the same lot and specification will allow rejection of any wheel with a suspiciously different ring before use.

UNIT IX: SURFACE GRINDER OPERATION

TASK PACKAGE 2: DRESSING WHEELS

PREREQUISITES: UNIT IX, TASK PACKAGE 1

RATIONALE:

You already know how to dress one wheel - yourself. But what do you know about dressing a grinding wheel? You're not a grinding wheel because you're not a grind in your studies. You're a big wheel on campus. So, Big Wheel, let's learn to dress grinding wheels.

As you saw in the last task package, the surface grinder or just about any grinding machine can do very accurate work. For the machine to do this accurate work it must have a lot of help from the machinist. You, as a machinist, must develop your skills so that you can command the most efficiency from the machine you are controlling. Inaccurate work reflects directly on the machinist; this is why machinists are very precise in all that they do on and off the job.

In this task package you will learn to accurately dress the grinding wheel on the surface grinder. This is not a hard task if it is done properly and in a careful and craftsman-like manner, which is the way you should always work.

A good machinist works to build his reputation and spends his working life guarding that reputation. Be a good machinist!

OBJECTIVE:

Upon completion of this task package you will be able to use the diamond tip dresser to dress the grinding wheel to a true shape in relationship to the magnetic chuck or work table surface. Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View slide-sound program M-XI-2, starring Hot Wheels.
2. Read the following reference materials:
   a. Machine Shop Operations and Setups, pages 363 to 368.
   b. Machine Tool Technology, Units 116 and 117, pages 444 to 447.
   c. Blueprint Reading for Machinists, Units 11, 12 and 14.
3. In reference a, on page 397, there are some safety precautions. In the spaces below write the rules 1, 2, 5, 6, 7, and 8.

   a.

   b.

   c.

LEARNING ACTIVITY:

d.

e.

f.

4. Do not just write these rules. Study them, learn them, and practice them!
5. When you have finished the rules and your reading, see your instructor and show him your work. You are ready for your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Surface grinder
2. Grinding wheel
3. Wheel dresser

1. Install and true a grinding wheel on the surface grinder.
   a. Select and install a grinding wheel.
   b. Install the diamond point wheel dresser. (Yes, this is a real diamond, but it's not worth much because it's an industrial quality diamond and not a gem quality stone.)
   c. Adjust the wheel dresser. Do not turn the machine on yet.
   d. Have your instructor check your setup and demonstrate how to dress the wheel.

LEARNING PRACTICE (cont'd):

e. You demonstrate to your instructor how to dress the wheel.

f. After the wheel has been dressed, clean up the machine and area, remove the wheel, and store it.

A grinder produces accurate work if the machinist is skilled enough to properly true the machine. Never blame the machine for your shortcomings!

You can reach your dream without becoming a regular grind, but you must be able to dress wheels well - just as you've shown you can do.

M-IX-3

UNIT IX: SURFACE GRINDER OPERATIONS

TASK PACKAGE 3: TRUING WORKPIECE

PREREQUISITES: UNIT IX, TASK PACKAGE 2

RATIONALE:

This package is not flat reading. It is concerned with flat surfaces, true, but it holds more things of interest to the student of metals. Have a look at it right now.

The surface grinder is probably the most common of the grinding machines that are used in the machine shop. One of the reasons for this is the large number of flat surfaces that are ground for maximum accuracy. Another reason is the ease with which flat workpieces may be secured to the table of the surface grinder.

Besides the usual holding devices that are used in the machine shop, the surface grinder has a magnetic chuck that is normally used when working with this machine. These chucks are flat table-like devices and come in different sizes and shapes. To use one for holding a workpiece, the machinist simply places the workpiece on it and turns on the magnetic power. With a flip of a switch the workpiece is held safely and securely to the magnetic chuck.

Sound like fun? The magnetic chuck is waiting for you in this task package.

OBJECTIVE:

Upon completion of this task package you will be able to perform the following:

a. position and secure the workpiece on the magnetic chuck.

b. align the workpiece surface parallel to the face of the grinding wheel to an accuracy of ± .001 of an inch, using the dial indicator.

Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View sound-slide program M-IX-3, a four-star extravaganza.
2. Reference reading for this task package is:
    a. Machine Shop Operations and Setups, page 364, the topic Setups and Operations - Horizontal Surface Grinding. Note figure 3 on page 365.
    b. Machine Tool Technology, page 436, the topic General Procedure. Note the pictures on pages 436 and 437.
    c. Blueprint Reading for Machinists, Units 20 and 21.

LEARNING ACTIVITY (cont'd):

3. Reference a, page 397 has some safety precautions. In the space below, write rules 3, 4, 9, and 10:

   a.

   b.

   c.

   d.

4. When you have completed the above assignment, show your work to your instructor and proceed to the Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Surface grinder	3. Dial indicator
2. Magnetic chuck	4. Precision vise

1. Obtain from your instructor two flat pieces of steel about 6" in length, 1" in width, and 1/2" in thickness.
2. Prepare the surface grinder for grinding with a magnetic chuck.
   a. Install a grinding wheel.
   b. True the grinding wheel with a wheel dresser.
   c. Install the magnetic chuck.
   d. Indicate the magnetic chuck with the dial indicator.
   e. Secure the workpieces to the magnetic chuck.

LEARNING PRACTICE (cont'd):

f. Have your instructor check your workpieces.

g. Remove the workpieces.

3. Prepare the surface grinder for grinding with a vise on the magnetic chuck:

   a. Clean the surface of the magnetic chuck.

   b. Clean the mating surface of the vise.

   c. Place the vise on the magnetic chuck.

   d. Insert a workpiece in the vise.

   e. Indicate the workpiece with the dial indicator.

   f. Turn on the magnetic chuck.

   g. Indicate the workpiece again.

   h. Have your instructor check your work.

   i. Remove the setup from the grinder; put away the vise, and clean the machine.

   NOTE: Keep these workpieces for the next task package.

The magnetic chuck makes using the surface grinder an easy task, but there are times when the machinist must use other holding devices. Think before you make your setup and don't rely on just one method of hold-downs.

Nothing is holding you down from becoming a skilled machinist.

M-IX-4

UNIT IX: SURFACE GRINDER OPERATIONS

TASK PACKAGE 4: GRINDING WORKPIECES

PREREQUISITES: UNIT IX, TASK PACKAGE 3

RATIONALE:

You know that they grind coffee, don't you? Well, there are other types of grinding, too. Let your attention dwell here on grinding workpieces.

In this task package you will begin grinding on the surface grinder. Your first job will be making a set of parallel bars to the specifications of a drawing you will also make.

It is not unusual for the machinist to make a drawing of a part and then to produce that part, nor is it unusual for the machinist to be given a drawing and make a part from it. The point is, there is little that is unusual for the machinist and, as you become more skilled in this trade, you will find yourself involved in a variety of jobs until a day comes when you will feel you can do just about anything. This is the day you will know you are a machinist.

The machine shop is the place for the man of many talents, and the man of many talents belongs in the machine shop.

OBJECTIVE:

Upon completion of this task package you will be able to grind workpieces. The standard of accuracy will be determined by the specification of the drawing.

LEARNING ACTIVITY:

1. View slide-sound program M-IX-3, featuring Sir Face Grinder.
2. Read the following reference material for this task package:
   a. Machine Shop Operations and Setups, pages 361 to 368. This is review reading.
   b. Machine Tool Technology, Unit 114, pages 434 to 442, and Unit 121, pages 452 to 455.
   c. Blueprint Reading for Machinists, Units 22 and 23. This is a review of mathematics.
3. Using the bar stock from task package 3 as a guide, make a three-view drawing of one of these pieces.
   a. See Unit 2 of reference c for a three-view drawing.
   b. Include on your drawing the exact dimensions of the piece of bar stock.
   c. Reduce all dimensions, except the length, by .0625 of an inch.
   d. Make your drawing as professional looking as you can.

LEARNING ACTIVITY (cont'd):

4. When you have finished the drawing and the reading, show your work to your instructor. You are ready for the Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Surface grinder
2. Magnetic chuck
3. Grinding wheel
4. Measuring tools
5. Dial indicator

1. Using the drawing you made in the Learning Activity, grind two pieces of bar stock to the specifications of your drawing.
   a. Select the grinding wheel.
   b. Install the grinding wheel.
   c. True the grinding wheel.
   d. Install the magnetic chuck.
   e. Indicate the magnetic chuck.
   f. Secure workpieces to the magnetic chuck.

   NOTE: Do not remove all the material from just one side of the workpiece.

   g. Have your instructor check your setup.
   h. Grind the workpieces.

   NOTE: Rough cut about .003 of an inch. Finish cut about .001 of an inch.

   i. Check the workpieces for accuracy.

LEARNING PRACTICE (cont'd):

j. Have your instructor check the workpieces for accuracy.

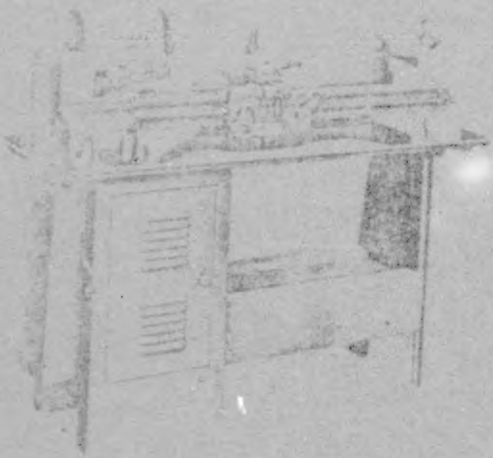
k. Remove the setup, carefully clean the machine and area, and put away tools and equipment.

2. You should now have a set of parallel bars that are fairly accurate.

This was a somewhat simple job and a type of job that is done many times on the surface grinder. The surface grinder is capable of doing many jobs, some of which you have discovered in your reading. What this machine can do is largely up to the machinist.

Grind your way through to new skills in metals.

RESEARCH PROJECT
SANFORD CENTRAL HIGH SCHOOL
1706 NASH STREET
SANFORD, NORTH CAROLINA 27330



CLUSTER: METALS
COURSE: MACHINE SHOP

UNIT PACKAGE X: SHAPER OPERATIONS

PREREQUISITE: UNIT I

RATIONALE:

In this unit you will study and operate the shaper. The shaper is a versatile machine that is used in the machine shop for machining workpieces that need straight cuts or it may be used in special applications that are suited to the shaper.

Your learning will be a step by step process that starts with an introduction to the machine and continues through the various steps until you perform machining operations on the shaper.

The various machining operations that you will perform are basic ones that will give you a good foundation for expanding your knowledge and skills in the future. A future that is almost unlimited if you are willing to develop those habits and skills that are required of a first class machinist. First class is the only way to go!

OBJECTIVES:

General:

Upon completion of this unit you will be able to do various machining operations on the shaper.

OBJECTIVES (cont'd):

Specific:

Upon completion of the task packages for this unit, you will be able to:

1. Use a vise or other holding device to secure a workpiece on the shaper table in a safe manner. Your performance will be evaluated in accordance with the instructor's checklist.
2. Use a dial indicator to true the workpiece and/or holding device on a shaper. An accuracy of ± .001 of an inch will be the acceptable standard of performance.
3. Select and install the proper cutting tool on a shaper for the workpiece being machined and the type of cut being made. Your performance will be evaluated in accordance with the instructor's checklist.
4. Adjust the length of the stroke to insure the maximum removal of material. Performance requirements will be consistent with good machining practices as stated in Machine Tool Technology and Machine Shop Operations and Setups. Your performance will be determined in accordance with the instructor's checklist.
5. Given a specific material and machining operation, set the feed and speed on the shaper with the aid of reference material. Your performance will be evaluated in accordance with the instructor's checklist.

OBJECTIVES (cont'd):

6. Use roughing and finishing tool bits to make vertical cuts on a workpiece. An accuracy of ± .001 of an inch will be the standard of acceptable performance.
7. Use left and right-hand tool bits to make horizontal and dovetail cuts on a workpiece. An accuracy of ± .001 of an inch will be the standard of acceptable performance.
8. Use roughing and finishing tools to make angular cuts on a workpiece. An accuracy of ± .001 of an inch will be the standard of acceptable performance.
9. Use the proper tool bit for the type of cut and material to make stopped cuts in a workpiece. An accuracy of ± 1/64th of an inch will be acceptable standard of performance.

LEARNING ACTIVITY:

There are nine task packages in this unit and they have been designed to be worked in sequence from 1 to [illegible] In this manner you will acquire a skill and then build on that skill in the next task package until you are able to operate the shaper with confidence. Each task package is important in the chain of learning, so work hard on each one.

There will be times, when you are working on the task package, that you will have questions about the work you are doing or some phase of the machine shop. Ask the Resource Center Director or your

LEARNING ACTIVITY (cont'd):

instructor these questions. They will be pleased to help you at any time.

In the packages you will be asked to view a sound-slide presentation, read and answer questions, and perform some practical exercises. The number and names of the task packages included in this unit are as follows.

TASK PACKAGE 1: SECURING WORKPIECE
TASK PACKAGE 2: TRUING WORKPIECE
TASK PACKAGE 3: CUTTING TOOLS
TASK PACKAGE 4: ADJUSTMENT OF STROKE
TASK PACKAGE 5: SPEED AND FEED
TASK PACKAGE 6: VERTICAL CUTS
TASK PACKAGE 7: HORIZONTAL AND DOVETAIL CUTS
TASK PACKAGE 8: ANGULAR CUTS
TASK PACKAGE 9: STOPPED CUTS

At this point you may feel that you can perform all of the above tasks on the shaper. If so you may ask your instructor about the comprehensive unit test. If you feel you couldn't pass this test, then start with the first task package and learn to operate the shaper.

UNIT X: SHAPER OPERATIONS

TASK PACKAGE I: SECURING WORKPIECE

PREREQUISITES: UNIT I

RATIONALE:

Security is the concern of practically everybody and everything. The same is true of your workpiece. Therefore, here's the chance for you to give your workpiece some security.

While the shaper is not the oldest machine tool in the machine shop (the lathe is), it has been around for quite sometime. For many years it filled the gap for machining flat surfaces. In time, the versatility of the shaper was increased so that it could be used to machine on a vertical or angular surface. Continued improvements have been made, over the years, so that now the shaper has become an extremely versatile machine.

In this task package you will be introduced to the shaper, and also to the devices that are used to hold the workpiece on the shaper table. Because of its method of cutting, it is very important that the workpiece be mounted on the shaper in a safe manner. The means of safely mounting workpieces on the shaper are available to you. Use them for the safety of the machine, but more importantly for your own safety. Machines can be remade; machinists can't.

OBJECTIVE:

Upon completion of this task package you will be able to use a vise or other holding device to secure a workpiece on the shaper table in a safe manner. Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View slide-sound program M-X-1, starring the security agent.
2. Read the following reference materials:
   a. *Machine Shop Operations and Setups*, page 240 to the topic Shaper Size or Capacity on page 244. Also, read the topic Shaper Work-Holding Devices on pages 249 to 252.
   b. *Machine Tool Technology*, Unit 79, page 291, to the topic Shaper Tools on page 295. Also, note the various methods of holding workpieces in the other units about the shaper.
   c. *Blueprint Reading for Machinists*, Units 6 to 11.
3. In reference b, on page 290, the parts of the shaper are shown. With some minor differences most shapers are somewhat alike. Learning the names of these parts will help you in running the shaper and also in communicating with other machinists.
4. What are the two parts of the shaper table?

   a. ______________________ b. ______________________

LEARNING ACTIVITY:

5. Does the speed of the shaper change with the length of the stroke?

____

6. What is the name of the feature that is used to bring the work in contact with the tool quickly? ______________________________

____

7. When you have completed the above work, check with your instructor and begin your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Shaper
2. Workpiece holding devices

1. Obtain from your instructor three different sized workpieces and have him mark the surface to be machined.
2. Install the workpieces on the shaper.
   - a. Select the workpiece holding device.
   - b. Mount the holding device on the shaper.
   - c. Insert the workpiece in the best manner for the machining operation.
   - d. Have your instructor check your setup.
   - e. Remove the first workpiece and install the remaining two pieces.
   - f. Have your instructor evaluate each setup.
   - g. Remove the setup from the shaper and return the stock and holding device to its proper place.

LEARNING PRACTICE (cont'd):

h. Wipe the machined surfaces of the shaper with a clean rag; then put a light coat of oil on these surfaces.

Examine the shaper and think carefully about what you have learned in this task package. One of the traits of the machinist is that he is a thinking man. Are you the type of man to be a machinist?

If you continue to acquire machinist's skills, they will provide you with a lifetime of security.

UNIT X: SHAPER OPERATIONS

TASK PACKAGE 2: TRUING WORKPIECE

PREREQUISITES: UNIT X, TASK PACKAGE 1

RATIONALE:

You've got to be true to your work in metals. This involves truing the workpiece. So learn the true facts about this process here.

How accurate any machine is depends a great deal on the skill of the machinist setting up the machine. If short cuts are taken when you mount a holding device (as an example, if you don't clean the mating surfaces), the end result will be a workpiece that will not meet the specifications and will end up as scrap. You, as the setup man, will be looked upon as a careless worker and your fellow machinists will feel you are not doing your job. You may, in fact, end up making a lot of extra work for yourself and the other men in your shop. The machinist is an individual, but he is also a part of the team.

In this task package you will learn to true the workpiece holding device and/or the workpiece. It is a job that requires thinking and skill on your part.

Thinking and skill are part of the machinist's trade!

OBJECTIVE:

Upon completion of this task package you will be able to use a dial indicator to true the workpiece and/or holding device on a shaper. An accuracy of ± .001 of an inch will be the acceptable standard of performance.

LEARNING ACTIVITY:

1. View sound-slide program M-X-1, starring Trudy.
2. Reference reading for completing this task package will be:
   a. Machine Shop Operations and Setups, pages 244 to 249, starting with the topic Shaper Size or Capacity and ending with the topic Cutting Tools Used with Shapers. Also on pages 255 and 256, the topic Adjusting Vise to Ram.
   b. Machine Tool Technology, Unit 83, page 305.
   c. Blueprint Reading for Mechinists, Units 11 and 12, pages 55 to 65.
3. In reference a, pages 277 & 278, there are some safety precautions for the shaper. Write rules 1, 2, & 3 in the spaces below:

   a.

   b.

   c.

NOTE: See Information Sheet No. 1, page 5.

LEARNING ACTIVITY (cont'd):

4. After finishing the above, report to your instructor and show him the results of your work. Start the Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Shaper
2. Workpiece holding device.
3. Dial indicator
4. Precision steel square

1. Obtain from your instructor the three workpieces used in the last task package or similar ones.
2. Install a vise on the shaper table:
   a. Clean the table surface and the mating surface of the vise.
   b. Set the vise jaws about parallel with the stroke direction.
   c. Check the seat of the vise for burrs and remove any that are present.
   d. Clamp the dial indicator to the shaper, using the tool post.
   e. Indicate the vise by moving the ram.
   f. Adjust the vise if necessary.
   g. Have your instructor check your work.
   h. Rotate the vise 90° and check it for trueness.
   i. Adjust the vise if necessary.
   j. Have your instructor check your work.

LEARNING PRACTICE (cont'd):

3. Insert a workpiece in the vise and true it:
   a. Indicate the workpiece in both directions.
   b. Adjust it as necessary.
   c. Have your instructor evaluate your work.
   d. Remove the setup from the shaper and clean and oil the machine.

The time spent in truing on a machine can be the most valuable time the beginning machinist will spend. It is only after this has been done properly that the machine can function as it is supposed to.

Learn now, so you can earn later!

1. Use the following procedure after you have mounted the vise on the shaper table.

Be sure that dirt does not get between the vise and the table surfaces because a very small particle between the surfaces will interfere with the parallelism of the vise with the table.

2. Set the vise jaws approximately parallel with the direction of the stroke. (Refer to Figure 1)

3. Open the vise to its full capacity.

4. Examine the work seat of the vise for burrs and carefully remove any that may be present.

5. Thoroughly clean the surface.

6. Select two test parallels high enough to project above the top of the vise jaws and long enough to extend two or three inches beyond the width of the vise (Figure 2)

NOTE: If parallels are not available, the indicated readings may be taken directly from the work seat of the vise.

7. Thoroughly clean the parallels and lay them carefully on the work surface of the vise. Place one against each of the vise jaws.

Figure 1

Figure 2

Figure 3

Figure 4

8. Arrange the parallels against the face of the vise jaws so that they both project evenly beyond the sides of the vise. Some mechanics prefer to place a piece of tissue paper under the ends of each parallel to insure good contact and to prevent slipping (Figure 2).

9. Select an indicator with the contact shaft perpendicular with the dial (Figure 8). The dial faces upward and can be conveniently read from the operating position.

   NOTE: Dial indicators are made with two types of contact shafts, one parallel and the other perpendicular to the face of the dial. Figures 5 and 8 illustrate the arrangement for both types of indicators.

10. Reverse the position of the tool holder in the tool post. This will provide a more convenient surface upon which to place the clamp because the tool end which contains the set screw and the tool has an irregular surface. (Figure 3).

11. Attach a small, ball type contact point to the end of the indicator contact spindle. This point is simply screwed into the end of the contact spindle, and, when necessary, can be removed quite easily (Figure 4).

12. Assemble the indicator, the gage-holding rod, the swivel or sleeve, and the clamp.

13. Clamp the assembled unit to the end of the tool holder with the dial facing upward (Figures 6, 7 & 8).

14. Manipulate the down-feed crank and the cross-feed table control handle until the contact point is about one half inch above one of the parallels.

Figure 6 Figure 7 Figure 8

Figure 9

15. Set the machine so that the length of the stroke is about one inch shorter than the length of the parallels. (Figure 9)

16. Position the ram so that the contact point travels within one half inch of both ends of the parallels.

If the ram with the attached indicator cannot be operated by hand, use a slow speed to move the indicator back and forth over the parallel. Great care must be exercised that the point of the indicator is not allowed to travel beyond the surface of the parallel. If this should happen, the point would drop below the level of the surface and would damage the indicator when the return stroke is made. This is also the reason for having both parallels project evenly beyond the sides of the vise. (Refer to operation No. 8.) In other words, both parallels must be set in the same relation to the position of the stroke when the testing operation is in progress; otherwise there is the possibility of the indicator traveling beyond the surface of one of them.

Figure 10

17. Move the ram so that it is at the beginning of the stroke, and move the table so that one end of the parallel is under the contact point of the indicator as shown at A, Figure 10.

18. Lower the indicator until the pointer registers about ten one-thousandths of an inch on the dial. This will make certain that the point is making contact with the parallel.

19. Note the measurement on the dial; then move the ram to the forward position B. If the vise is parallel, the indicator will show the same reading at both ends of the parallel.

Figure 11

20. Bring the surface C of the second parallel under the indicator, raising the contact shaft slightly with the finger as the parallel is moved directly underneath the point of the indicator (Figure 11).

21. Release the contact shaft and allow the contact point to rest on the parallel. The reading at C should be the same as the readings at A and B.

22. Finally, draw the ram again to the beginning of the stroke. If the reading at D corresponds with all the others, the vise is parallel.

23. If B and C are low, adjust the table support and tighten the table gibs. This may be all that is necessary to bring these points into alignment.

24. If A, B, C, or D is low, loosen the clamping nuts and place a paper shim underneath the lowest point of the base, after making certain, of course, that there are no particles of dirt underneath the base of the vise.

25. Tighten the nuts and recheck the setting at all four points. Follow the instructions given in the preceding operations if further adjustments must be made. (Figure 12.)

Figure 12

UNIT X: SHAPER OPERATIONS

TASK PACKAGE 3: CUTTING TOOLS

PREREQUISITES: UNIT X, TASK PACKAGE 2

RATIONALE:

Proper selection -- that's another secret of success. This fact holds true in many areas. With cutting tools, it's extremely important, as you will learn here.

After you have secured and trued the workpiece on the shaper table, the selection of the cutting tool is the next step in preparing the shaper for cutting operations.

In this task package you will learn about shaper cutting tools, how they should be ground, and the correct tool bit for different operations. You will also install different cutting tools on the shaper and learn a few more things about this machine. Sounds like a lot to learn, doesn't it? It is a lot to learn, but if you proceed with your assignments in a logical manner, you will be able to understand most of the information you will be exposed to. Those items of information that you don't understand, you can ask your instructor about.

The smart machinist uses all sources of information.

OBJECTIVE:

Upon completion of this task package you will be able to select and install the proper cutting tool on a shaper for the workpiece being machined and the type of cut being made. Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View slide-sound program M-X-1, starring Mr. Selecto.
2. To help you complete this task package read:
   a. Machine Shop Operations and Setups, pages 248 and 249, the topic Cutting Tools Used with Shapers. Also note figure 9, page 249.
   b. Machine Tool Technology, Unit 55, pages 238 to 242, and Unit 79, starting with the topic Shaper Tools on page 295.
   c. Blueprint Reading for Machinists, Unit 14, pages 69 to 73.
3. In reference a, on page 273, are safety precautions. Write rules 4, 5, and 6 in the spaces below:
   a.

   b.

   c.

LEARNING ACTIVITY (cont'd):

4. Do you know the difference between the shaper and the planer? What is the difference? Write your answer below.

5. There is a mistake in the reference Machine Tool Technology; on page 241 under the topic Procedure for Grinding Shaper Tools, you are told to check Unit 54, Table 8. Table 8 is in Unit 52 on page 226. Make sure you check this table.

6. Ordinarily little or no back rake is desired on shaper tool bits. Explain in writing what back rake is.

7. For moderate to heavy cuts, the tool holder and the tool generally are ______________________.

8. Will the lathe tool holders that have a 16° to 20° angle work well on the shaper? ______________________

9. What can you use to cut a keyway on the inside of a wheel?

____

10. Shaper tool bits are ground with a side relief of about _____° to _____°.

11. See your instructor when you have finished the above work. You may start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Shaper
2. Tool holder
3. Tool bits

1. Select and install on the shaper the proper tool bit for the following operations: (See figure 1.)
   a. Roughing tool for steel.
   b. Roughing tool for cast iron.
   c. Left-hand side roughing tool.
   d. Finishing tool for steel.
2. Have your instructor check your tool selection and the way you install each one.
3. When you have completed the above Learning Practice, clean up the machine and area. Put a light coat of oil on all the machined surfaces.

The proper selection of a cutting tool and the way in which you install it can be the key to a successful operation on the shaper. The good machinist knows his tools, machine, and himself!

Selection of a career in metals can lead you to enjoyment and prosperity.

M-X-4

UNIT X: SHAPER OPERATIONS

TASK PACKAGE 4: ADJUSTMENT OF STROKE

PREREQUISITES: UNIT X, TASK PACKAGE 3

RATIONALE:

This package could bring you a stroke of good fortune. So get in shape and learn about stroke adjustment here.

In this task package you will learn to adjust the length of the stroke of the shaper ram. Along with the adjustment you will also learn how to position the stroke so that the shaper will perform more useful work in a shorter period of time. Both of these adjustments are performed to increase the machine's efficiency, and this of course increases your efficiency as a machinist. To become an efficient machinist and to work as a skilled craftsman should be the goals you are striving for.

OBJECTIVE:

Upon completion of this task package you will be able to adjust the length of the stroke to insure the maximum removal of material. Performance requirements will be consistent with good machining practices as stated in *Machine Tool Technology* and *Machine Shop Operations and Setups*. Your performance will be determined in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View sound-slide program M-X-4, a five-star thriller.
2. Reading references for completing this task package are:
   a. *Machine Shop Operations and Setups*, pages 251 to 255.
   b. *Machine Tool Technology*, Unit 81, page 301.
   c. *Blueprint Reading for Machinists*, Units 20 and 21.
3. The amount of o[illegible]lap required in shaper operations depends on seven factors. List these seven factors below.
   a.

   b.

   c.

LEARNING ACTIVITY (cont'd):

d.

e.

f.

g.

4. The stroke on the shaper should be at least ___________" longer than the cut.

5. Explain, in the space below, the difference between stroke length and stroke position. ______________________________

____

6. Which is adjusted first, the stroke length or the stroke position? Stroke ___________.

7. To raise or lower the shaper table the __________ clamp and the saddle-clamping __________ must first be loosened.

8. Testing the workseat of a vise for ______________ to the stroke of the ram should precede any setup.

9. Have your instructor approve the above work and start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Shaper
2. Workpiece holding device
3. Tool bit holder
4. Tool bit
5. Necessary tools
6. Dial indicator
7. Machinist's scale

1. Obtain from your instructor a workpiece on which he has marked the area to be machined.

2. Secure the workpiece in the shaper and adjust the stroke and position of the ram.

   a. Carefully mount the workpiece holder on the shaper.

   b. True the workpiece holder.

   c. Install a cutting tool. For practice select the proper tool for this job.

   d. Adjust the stroke of the ram. Do not turn the machine on.

   e. Adjust the position of the ram.

   f. Have your instructor evaluate your setup.

   g. Your instructor will demonstrate starting the machine.

   h. Remove your setup and carefully return all tools and equipment to their proper places.

   i. Clean the machine and area. Apply a light coat of oil to all machined surfaces.

LEARNING PRACTICE (cont'd):

It should be easy for you to see the importance of properly adjusting the length and position of the stroke. Yet, you will see, as you work around the machine shop, many new machinists who will not take the time to do these adjustments. It appears that you're stroking along toward a career in metals.

M-X-5

UNIT X: SHAPER OPERATIONS

TASK PACKAGE 5: SPEED AND FEED

PREREQUISITES: UNIT X, TASK PACKAGE 4

RATIONALE:

Don't let this package make you feel cranky. Among other things, it is concerned with the machine-crank shaper and its speed. So crank up and get speedy in studying these new machinist's skills.

Of the many factors that determine the quality of the job that is done on the shaper, the factors of proper speed and feed are among the most important. These factors are also important for determining the amount of time required for doing a job on the shaper.

As a machinist you will want to do the highest quality job in the shortest length of time. Therefore, it is to your advantage to learn as much as you can about using feeds and speeds on the shaper in an efficient manner.

In this task package you will learn about speeds and feeds and also how to set them on the shaper. When you understand the role of these important factors, you will be ready to start machining operations on the shaper.

OBJECTIVE:

Upon completion of this task package you will be able to, given a specific material and machining operation, set the feed and speed on the shaper with the aid of reference material. Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View sound-slide program M-X-5, starring Mr. Cranky.
2. To assist you in completing this task package read the following reference materials:
    a. Machine Shop Operations and Setups, pages 267 to 270. Read the topic Shaper Speed and Feeds and study the safety rules on page 270.
    b. Machine Tool Technology, Unit 80, page 300.
    c. Blueprint Reading for Machinists, Units 22 and 23, pages 101 to 114. This is to help you review your mathematics skills. If you find you need additional help, try working with the Mathematics for Vocations packages.
3. The safety rules on page 270 of reference are excellent ones for the machinist to live by. In the space below write rules 1, 2, and 3.

LEARNING ACTIVITY (cont'd):

a.

b.

c.

4. The speed of a machine-crank shaper is governed by the ________ gear or __________ wheel.

5. Cutting speeds are changed, on the shaper, by changing the _______ and the __________ of rocker-arm movement.

6. There are two speeds on the shaper. These are the ____________ speed and the ____________ speed.

7. In most shapers, it takes about _______________ times as long to make the cutting stroke as it does the return stroke.

8. In horizontal shaping, the feed is defined as the distance the work is moved toward the cutting tool for each ____________ stroke of the ram.

9. What are the two ways of feeding the workpiece?

a ______________________ b __________________

10. Cutting speed is always given in ____________ per minute.

11. After you have finished the above work have your instructor check your progress. You may then start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Shaper

LEARNING PRACTICE (cont'd):

1. Your instructor will assign you a shaper to work with.
2. Set the speed for the following materials with a stroke length of six inches and using a high-speed steel cutting tool.
   a. Mild machine steel.
   b. Tool steel.
   c. Cast iron, soft.
   d. Brass.
3. Set the speeds for using a carbon steel cutting tool.
4. When you feel you understand how to set the speeds, have your instructor evaluate your work.
5. Your instructor will ask you to set the different feeds.
6. If your instructor is satisfied with your understanding of feeds and speeds, you may consider yourself finished with this task package.

You have now completed all the basic steps for machining work on the shaper. In the next task package you will begin cutting metal on the shaper so don't forget the lessons learned in these task packages.

You're on your way - so don't delay.

M-X-6

UNIT X: SHAPER OPERATIONS

TASK PACKAGE 6: VERTICAL CUTS

PREREQUISITES: UNIT X, TASK PACKAGE 5

RATIONALE:

Combine your skills. That's the secret of success. An isolated skill is not of much use in itself. But if you combine several of them, you'll get more accomplished.

You are ready to combine what you have learned in the last few task packages into a complete machining operation. Each of the preceding task packages has been a step leading to the eventual machining of a workpiece.

In this task package you will learn to use the shaper to make vertical cuts on a piece of metal. What you will be doing, in effect, is squaring the ends of this workpiece with the top, bottom, and sides. You will end up with a squared block of metal, that will be used in future shaper operations.

Since you will be using this workpiece in other operations, do the machining carefully and accurately. Make care and accuracy a habit in all your work.

Good luck and enjoy your first machining operation on the shaper!

OBJECTIVE:

Upon completion of this task package you will be able to use roughing and finishing tool bits to make vertical cuts on a workpiece. An accuracy of ± .001 of an inch will be the standard of acceptable performance.

LEARNING ACTIVITY:

1. View sound-slide program M-X-6, featuring Vertie Cutt.
2. Reference reading for this task package is:
   a. Machine Shop Operations and Setups, pages 258 and 259, the topic Shaping Vertical Surface.
   b. Machine Tool Technology, Unit 84, pages 306 to 309.
3. In reference a, on page 270, there are some safety precautions. Write rules 4, 5, and 6 in the space below.

   a.

   b.

   c.

4. Upon completing the above work, show it to your instructor and begin your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Shaper
2. Workpiece holding device
3. Tool bit and holder
4. Dial indicator
5. Layout tools
6. Measuring tools

1. Obtain from your instructor a piece of stock about 4" in length, 2" in width, and 1 1/2" thick.

2. Included in this task package is a drawing. Keep this drawing and your stock for use in future task packages.

3. Using the stock obtained from your instructor, square both ends, using a vertical cut.

   NOTE: Lubricate the machine.

   a. Install the workpiece holding device on the shaper.
   b. True the workpiece holding device.
   c. Secure the workpiece in the holding device.
   d. True the workpiece.
   e. Install the cutting tool.
   f. Adjust the clapper box.
   g. Set the feed and speed.
   h. Adjust stroke length and position.
   i. Have your instructor check your setup.
   j. Machine the workpiece.
   k. Have your instructor check the workpiece.

LEARNING PRACTICE (cont'd):

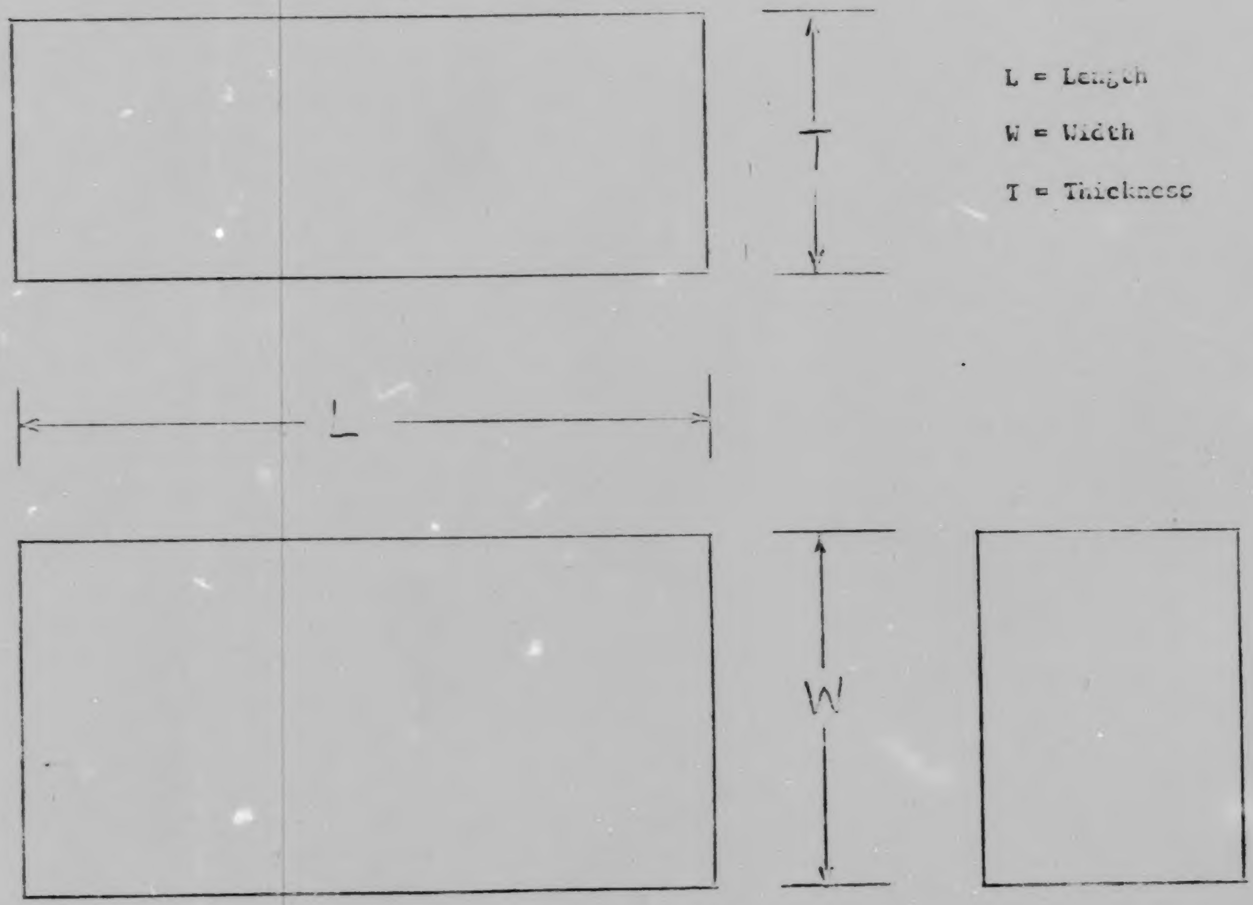
l. Carefully measure the workpiece and put the dimensions on the drawing.

m. Clean up the machine and area, put away tools and equipment, and put a light coat of oil on machined surfaces.

Now that you have completed your first operation on the shaper, you are ready for new experiences on this machine. The next three task packages are waiting to give these to you.

Combined skills produce excellent results.

SHAPER BLOCK



L = Length

W = Width

T = Thickness

UNIT X: SHAPER OPERATIONS

TASK PACKAGE 7: HORIZONTAL AND DOVETAIL CUTS

PREREQUISITES: UNIT X, TASK PACKAGE 6

RATIONALE:

Do you like dove hunting? No, this package is not concerned with this type of hunting. It's about dovetailed cuts. So hunt out the knowledge it contains for you.

The successful machinist is a man who can take previous experiences and expand and combine them to accomplish a numberless array of jobs in the machine shop. To prepare himself for his job, a good machinist will attempt about any job that comes his way. Rarely will you hear him give a quick "no" to an impossible or almost impossible job. The machinist becomes, by nature of his job, and the habits developed from the job, a man who is slow to say "no" to an assigned task. These are some of the traits that you will be expected to develop over the years and now, as you are doing these task packages, is the time to start developing these traits.

In this task package you will learn to surface a workpiece and cut a male dovetail on it. These are basic operations that you will repeat in one form or another many times in the years ahead.

OBJECTIVE:

Upon completion of this task package you will be able to use left and right-hand tool bits to make horizontal and dovetail cuts on a workpiece. An accuracy of ± .001 of an inch will be the standard of acceptable performance.

LEARNING ACTIVITY:

1. View sound-slide program M-X-7, a dovey show.
2. Reference assistance for this task package is:
   a. Machine Shop Operations and Setups, pages 256 to 259. The topics Shaping Horizontal Surface and Suggestions On How To Shape A Horizontal Surface. Note figure 9 on page 249.
   b. Machine Tool Technology, Unit 82, pages 302 to 305 and Unit 84, pages 306 to 309.
3. Modify the drawing from task package M-X-6 to show a male dovetail similar to the one shown on page 303, figure 10-43, of reference b. The top surface of the dovetail will be 1/3 T and the angle of the cut will be 60°. The depth of cut for the dovetail will be 1/4 W. Do not include dimensions at this point, but show the dovetail on all three views.
4. After completing the above assignments, have your instructor check your work. You may then proceed to the Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Shaper
2. Workpiece holding device
3. Rough and finishing tool bits
4. Tool bit holders
5. Layout tools
6. Measuring tools
7. Dial indicator

1. Using the drawing you modified in the Learning Activity and the part you machined in task package 6, surface the top of the workpiece and cut a male dovetail.

   Note - Lubricate the shaper.

   a. Install a workpiece holding device on the shaper table.
   b. True the workpiece holding device.
   c. Install the workpiece for machining the top surface.
   d. True the workpiece.
   e. Install a cutting tool and holder.
   f. Set the feed and speed.
   g. Adjust the stroke length and position.
   h. Have your instructor check your setup.
   i. Machine the top surface of the workpiece.
   j. Have your instructor check your work.
   k. Measure the workpiece and correct your drawing with the new dimensions. At this point enter the dimensions for the

LEARNING PRACTICE (cont'd):

male dovetail.

l. Lay out the dovetail on the workpiece.

m. Have your instructor check the layout.

n. Machine the dovetail.

o. With measuring tools, inspect your work.

p. Have your instructor inspect your work.

q. Clean up the machine and area, return the tools and equipment, and cover the machined surfaces with a light coat of oil.

As you complete these task packages on the shaper, you will feel your confidence grow as your skills increase. Remember, you are the master of the machine, but only if you know more than it does!

Be true to your goals, and your goals will be true to you.

UNIT X: SHAPER OPERATIONS

TASK PACKAGE 8: ANGULAR CUTS

PREREQUISITES: UNIT X, TASK PACKAGE 7

RATIONALE:

You'd like to know all the angles, wouldn't you? Well, here's your chance to learn some more of them in this package on angular cuts.

How useful the shaper is depends mostly on the man operating it. His skill and knowledge, and his willingness to make the machine work for him, can almost expand the capability of a machine beyond the point for which it was made. However, before the machinist can be in complete command of his machine, he must first have a good knowledge of the basic operations that can be performed on it.

In this task package you will learn a very basic operation. This operation is machining angular cuts on a workpiece. You have already done a somewhat similar operation when you made a dovetail in the last task package, but there is enough of a difference between these operations to have you make an angular cut for the job in this task package.

OBJECTIVE:

Upon completion of this task package you will be able to use roughing and finishing tools to make angular cuts on a workpiece. An accuracy of ± .001 of an inch will be the standard of acceptable performance.

LEARNING ACTIVITY:

1. View slide-sound program M-X-7, a super thriller.
2. To aid you in completing this task package, read the following reference materials:
   a. Machine Shop Operations and Setups, pages 259 to 262, the topic Shaping Vertical Surface, and pages 264 to 268, the topic Shaper Maintenance.
   b. Machine Tool Technology, Unit 84, pages 306 to 309. This will be review reading.
3. In reference b on page 270, there are some safety precautions; write rules 7 and 8 in the space below.

   a.

   b.

LEARNING ACTIVITY (cont'd):

4. Modify the drawing from the last task package to show an angular cut or an incline 90° to the front, beginning (using the front view of the drawing as reference) at the lower left-hand corner and ending at a point 1/2W. on the right side of the front view. Insert the necessary dimensions for this cut on your drawing.

5. In what two views on your drawing will this cut be shown?

_______________ and _______________

6. Will your drawing show any hidden lines? _______________

7. Show this work to your instructor and proceed to your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Shaper
2. Workpiece holding device
3. Roughing and finishing tool bits
4. Tool bit holder
5. Surface gage
6. Layout tools
7. Measuring tools
8. Dial indicator

1. Machine an angular surface on the workpiece you machined in the last task package, using the drawing you modified in the Learning Activity as a guide.

   a. Install the workpiece holding device.

   b. True the workpiece holding device.

   c. Lay out the angular cut on the workpiece.

LEARNING PRACTICE (cont'd):

d. Using the surface gage, true the workpiece in the workpiece holding device.

e. Insert the tool bit and holder in the tool post.

f. Set the speed and feed.

g. Adjust the length and position of the stroke.

h. Inspect your setup. Do you need to adjust the clapper box?

i. Have your instructor inspect your work.

j. Machine the angular cut.

k. Inspect your work with measuring tools. Your accuracy should be ± .001 of an inch.

l. Have your instructor evaluate your work.

m. Clean the machine and area, return the tools and equipment, and put a light coat of oil on the machined surfaces of the shaper.

n. Keep the workpiece and drawing for use in the next task package.

Are you finding the shaper to be a versatile machine? It is, you know. How versatile this machine is depends a lot on how skillful you are. Don't let your machine down; let it work for you!

You're getting in shipshape condition for a machinist's career.

UNIT X: SHAPER OPERATIONS

TASK PACKAGE 9: STOPPED CUTS

PREREQUISITES: UNIT X, TASK PACKAGE 8

RATIONALE:

This is your last operation with the shaper. In these task packages you have learned to control this machine. In the machine shop trade there are machine operators and there are machinists. The difference between the two is that the machine operator is more or less controlled by the machine and the machinist is the man who commands and controls his machines.

In this task package you will learn to make two kinds of stopped cuts. The usefulness of this type of shaping operation will be readily apparent to you as you read about it and machine them on your workpiece.

One more thing before you start this last task package: There is much more to the shaper than what you have learned in these task packages, but it's up to you to increase your knowledge about this and the machine shop trades.

OBJECTIVE:

Upon completion of this task package you will be able to use the proper tool bit for the type of cut and material to make stopped cuts in a workpiece. An accuracy of ± 1/64th of an inch will be acceptable standard of performance.

LEARNING ACTIVITY:

1. View sound-slide program M-X-9, a shapely show.
2. Reference reading for this task package is:
   a. Machine Shop Operations and Setups, pages 261 to 265.
   b. Machine Tool Technology, Unit 85, pages 309 to 312.
3. You will again modify the drawing you have been using in the last few task packages to show two stopped cuts.
   a. Show on your drawing a stopped cut, 3/8 of an inch square, with one closed end, parallel to the length of the workpiece starting at a point 1/2 W. on the left-hand side of the front view and ending at a point 1/2 of an inch from the angular cut on a line constructed from the starting point, parallel to the length, and ending at the angular cut.
   b. Show on your drawing a stopped cut, 3/8 of an inch square, with both ends closed. This cut will be on the opposite side of the workpiece from the cut above and will begin 1/4 inch in from the edge of the workpiece and end 1/2" from the angular cut.

LEARNING ACTIVITY (cont'd):

4. Try to understand these directions and make the modifications specified without help. Don't be afraid to make mistakes. A pencil line on a piece of paper can be erased. If, after you have tried, you are unable to understand the directions, ask your instructor for help. Never be ashamed to ask for help; your instructor is always ready to assist you.

5. When you have finished with your drawing you may begin your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Shaper
2. Workpiece holding device
3. Tool bits and holder
4. Layout tools
5. Dial indicator
6. Measuring tools

1. Using the drawing you modified in the Learning Activity and the workpiece you machined in the last task package, machine two stopped cuts.

   a. Lay out the cuts on the workpiece.

   b. Mark the location of the drilled holes.

   NOTE: If you have not as yet done the task package on drilling, your instructor will drill the holes for you.

   c. Drill the holes.

LEARNING PRACTICE (cont'd):

NOTE: Lubricate the machine.

d. Secure workpiece holding device to shaper table.

e. True workpiece holding device.

f. Install the workpiece in the holding device.

g. True the workpiece.

h. Install tool bit and holder.

i. Set the feed and speed.

j. Adjust stroke length and position.

k. Have your instructor check the setup.

l. Make the first stopped cut.

m. Reposition the workpiece.

n. Make the second stopped cut.

o. Carefully inspect your work.

p. Have your instructor inspect your completed part.

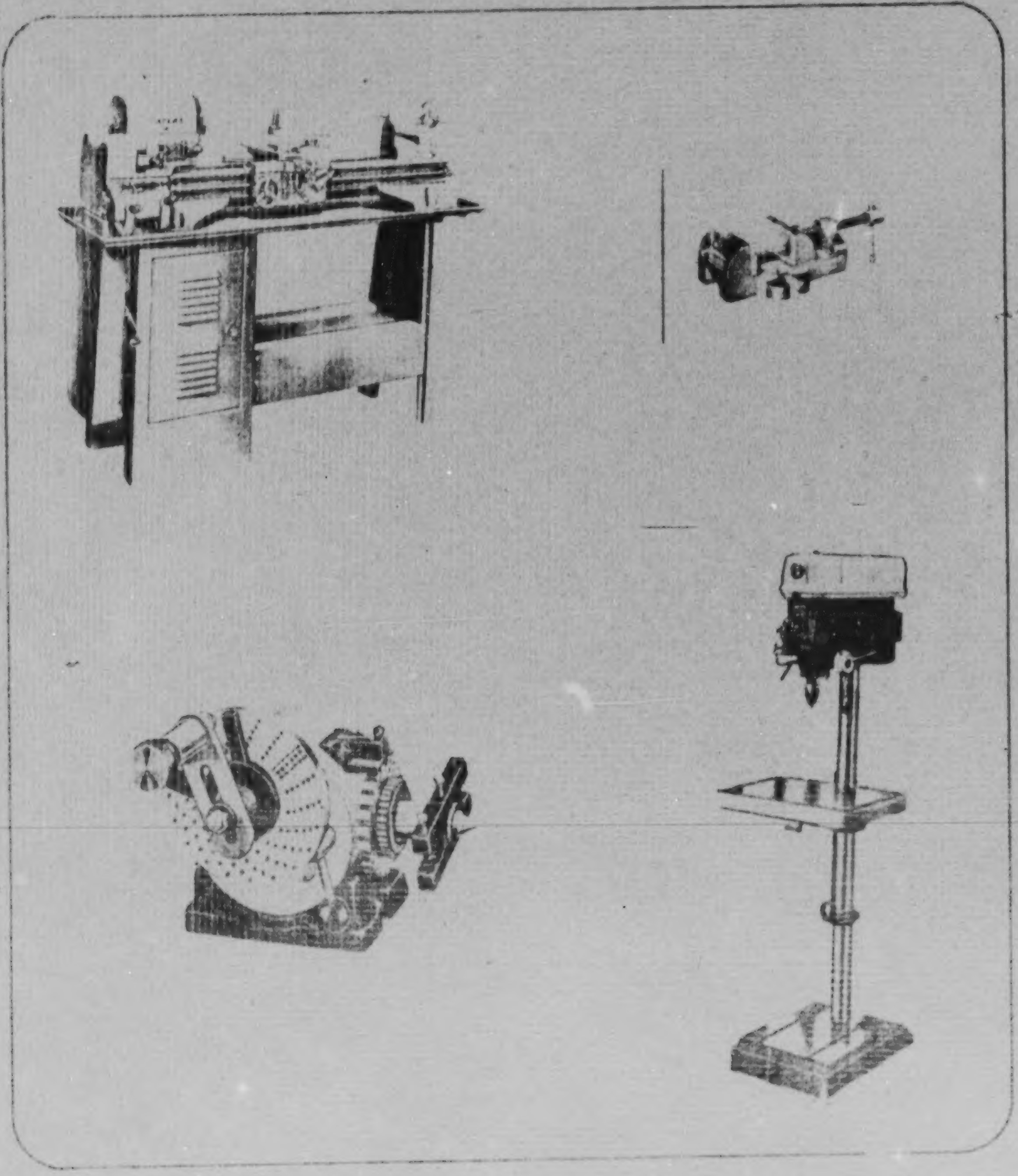
q. Clean the shaper and the area, put away the tools and equipment, and coat the machined surfaces with oil.

You now have a crazy-looking part. Yet, if you examine some of the parts on the machines in the machine shop, you will find some that are just as odd looking.

The shaper can do many operations, but only if you, the machinist, can guide it.

You keep shaping up for a career as a skilled machinist.

RESEARCH PROJECT
SANFORD CENTRAL HIGH SCHOOL
1708 NASH STREET
SANFORD, NORTH CAROLINA 27330



CLUSTER: METALS
COURSE: MACHINE SHOP

CE003937(L)

UNIT PACKAGE XI: SHEET METAL

PREREQUISITES: UNITS I AND II

RATIONALE:

Metallurgy is the first of a variety of subjects you will study in this unit. Other subjects for study are sheet metal, seams, and fasteners. While this is a large variety of subjects, you will see that they are closely related topics of study.

You will also be given a chance to make a sheet metal box that will be useful for holding various articles and may be used for a tool box. The box will be made in the task packages and will be finished in the unit test, so save the box for the performance test.

The subjects you will learn in this unit are also related to the machine shop and will help you increase your knowledge of metals-knowledge you will need in order to be a machinist and craftsman.

OBJECTIVES:

General:

Upon completion of this unit you will have a knowledge of metallurgy and will be able to make and fasten simple sheet metal forms.

Specific:

Upon completion of the unit you will be able to:

1. Do the following:
    a. state in writing the meaning of the following properties of metals:

OBJECTIVES (cont'd):

(1) tensile strength
(2) hardenability
(3) hardness
(4) ductility
(5) malleability
(6) brittleness
(7) toughness
(8) corrosion resistance

b. define in writing the term alloy.

c. list in writing the two basic kinds of steel.

d. list in writing the three grades of carbon steel.

2. Use layout tools to lay out simple sheet metal forms. An accuracy of ± 1/32nd of an inch will be the acceptable performance.

3. Use hand and squaring shears to cut sheet metal. An accuracy of ± 1/64th of an inch will be the acceptable standard of performance.

4. Use a hand brake to bend sheet metal forms. An accuracy of ± 1/32nd of an inch will be the standard of acceptable performance.

5. Use the hand brake and seaming tools to bend and set a single hem, double hem, and grooved seam. An accuracy specified by the drawing of the part will be the performance requirement.

6. Use rivets, screws and nuts, and self-tapping screws to fasten sheet metal forms. An accuracy specified on the drawing of the part will be the performance requirement.

LEARNING ACTIVITY:

The task packages in this unit are designed to be worked in

LEARNING ACTIVITY (cont'd):

sequence. The first task package will give you a knowledge of some of the properties of metal and in the later packages you will see how these properties are used.

While working on these packages you may encounter problems or have some questions about your work. If so, you may ask the Resource Center Director or your instructor to help you out.

In the packages you will be asked to view a sound-slide presentation, read and answer questions, and perform some practical exercises. The number and names of the task packages included in this unit are as follows:

TASK PACKAGE 1: METALLURGY

TASK PACKAGE 2: SIMPLE FORMS

TASK PACKAGE 3: CUTTING SHEET METAL

TASK PACKAGE 4: BENDING

TASK PACKAGE 5: SEAMS

TASK PACKAGE 6: FASTENERS

At this point, if you feel you can pass a comprehensive test on the above material, you may contact your instructor for the unit test. If, however, you feel that you can't pass a test, do the task packages in this unit.

M-XI-1

UNIT XI: SHEET METAL

TASK PACKAGE 1: METALLURGY

PREREQUISITES: UNITS I AND II

RATIONALE:

In metallurgy, the sky is the limit. Yes, this science has contributed to space exploration and will continue to be important in this field. Start becoming familiar with these interesting techniques here, and your work may eventually soar aloft.

This is your introduction to the world of metallurgy. Metallurgy is defined as "the science and technology of metals" and is a rapidly growing field of science. One of the reasons for this rapid growth is the space program. New metals and new alloys of metals have been developed for the special needs of spaceships and also the hardware that is used in them. Also new metals have been developed for the construction, transportation, and farming industries. As you look around your home or your classroom you will see metal in many places. As a machinist, metal will become the most important material in your life.

In this task package you will learn how metals are made and some of their uses. The reference material is very basic, but very important for you to know. Study and enjoy this task package.

OBJECTIVE:

Upon completion of this task package you will be able to do the following:

a. state in writing the meaning of the following properties of metals:

(1) tensile strength	(5) malleability
(2) hardenability	(6) brittleness
(3) hardness	(7) toughness
(4) ductility	(8) corrosion resistance

b. define in writing the term alloy.

c. list in writing the two basic kinds of steel.

d. list in writing the three grades of carbon steel.

LEARNING ACTIVITY:

1. View slide-sound program M-XI-1, a hard-hitting show.
2. Reference reading for this task package is:
   a. Metalwork Technology and Practice, Units 18 to 22 and pages 131 to 164.
   b. Technical Metals, Unit 5, pages 34 to 51.
3. After you have carefully read your reading assignment, proceed to the Learning Practice.

LEARNING PRACTICE:

1. You will write the answers to the following questions on separate sheets of paper and give them to your instructor for evaluation. Do this in a neat manner and write clearly so that your instructor can read your work.
2. You may use the reference books listed in this task package to aid you in your writing and spelling.
3. Your instructor may want to ask you some questions about these subjects so don't just copy them. Read and understand the material and ask questions if you have problems.
4. You may also be asked some of this material on your unit test. Know it!
5. State in writing the meaning of the following properties of metals:
   - a. tensile strength
   - b. hardenability
   - c. hardness
   - d. ductility
   - e. malleability
   - f. brittleness
   - g. toughness
   - h. corrosion resistance.
6. Define in writing the term alloy.
7. List in writing the two basic kinds of steel.
8. List in writing the three grades of carbon steel.

   NOTE: Do not confuse kinds and grades.
9. You may want to try some experiments with some of the properties of metals. In your reading reference a file test and a spark

LEARNING PRACTICE (cont'd):

test are discussed. These two tests are often used by machinists. What are they used for?

a. File test ______________________________

b. Spark test ______________________________

10. Go to the machine shop and try these tests.

11. Turn your work into the instructor.

You have been introduced to the world of metallurgy. It is a world of science that many men, who start as machinists, enter and develop as a lifelong career. You may want to find out more about this field of science.

Metallurgy could really be your thing!

M-XI-2

UNIT XI: SHEET METAL

TASK PACKAGE 2: SIMPLE FORMS

PREREQUISITES: UNIT XI, TASK PACKAGE 1

RATIONALE:

Simplicity is still a virtue, even in an age of complexity. That's one reason for the study of simple basic forms. Another reason is that you can build increasingly complex items on the basis of training with simple forms.

You have been introduced to metallurgy in the last task package and learned a few things about the different properties of metals. Now you will get a chance, in the next few task packages, to see how these properties react when you work with metal.

As you do this work with sheet metal, try to identify those properties that you know about and see if you can understand how this knowledge can make you a better metal worker. It takes some thinking to do this, but then thinking is the backbone of the metals trades.

In this task package you will learn to lay out a simple and basic sheet metal form. The form will be that of a box. The box is used because, once you can make one, it is very easy to transfer the learning to other more complex sheet metal forms.

Enjoy being a sheet metal worker!

OBJECTIVE:

Upon completion of this task package you will be able to use layout tools to lay out simple sheet metal forms. An accuracy of ± 1/32nd of an inch will be the acceptable performance.

LEARNING ACTIVITY:

1. View sound-slide package M-XII-1, an outstanding feature.
2. To aid in completing this task package, read the following reference materials:
    a. Metalwork Technology and Practice, sections 789 to 799, pages 295 to 299.
    b. Technical Metals, Units 3 and 4, pages 25 to 35 and Units 6 and 7, pages 51 to 67. Also in section six, Units 44 and 45, pages 171 to 180.
    c. Blueprint Reading for Machinists, Units 11, 12, and 14.
3. Using the information in the reading references, make a drawing of a box. Use figure 634 on page 296 of reference a.
    a. Obtain from your Resource Center a piece of cardboard about 24" by 24".
    b. Your Resource Center will also have a drawing board and drawing tools.
    c. Lay out the box pattern on the cardboard.

LEARNING ACTIVITY (cont'd):

d. Carefully cut out the box layout.

e. Bend the box into shape and tape the edges.

f. Show the box to your instructor and proceed to the Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Measuring tools   3. Layout fluid

2. Layout tools

1. Obtain from your instructor a piece of sheet metal about 16" by 24".

2. Lay out the box on the sheet metal using the dimensions from the layout you made in the Learning Activity.

    a. Draw two perpendicular center lines on the sheet metal.

    b. Lay out the box from these center lines. NOTE - Your Resource Center Director or Instructor can help you if you need it.

    c. Use dividers to transfer measurements. This will greatly increase your accuracy.

    d. When you have finished your layout, carefully recheck all your measurements

    e. Have your instructor check your work.

LEARNING PRACTICE (cont'd):

f. Return all your tools. Keep your layout for future use. It is a good idea to scratch your name on the piece of sheet metal.

g. Clean up your area.

Machinists and sheet metal workers have a saying that makes a lot of sense: "Measure twice and cut once!"

Simplify and organize your plans for reaching your goal as a machinist.

UNIT XI: SHEET METAL

TASK PACKAGE 3: CUTTING SHEET METAL

PREREQUISITES: UNIT XI, TASK PACKAGE 2

RATIONALE:

Measure, measure - cut. Measure, measure - cut. This is the way to do it as you'll see from the proverb in the next paragraph.

As you will see from your reference reading in this task package, there are many ways in which you can cut metal. However, before you start cutting on a piece of metal, remember that old saying, "Measure twice, cut once." Once a piece of metal is cut, it is extremely hard to put it back together again.

Cutting metal is what this task package is all about. The best way to learn how to cut metal is to actually do it. So get on with this task package and do some cutting.

OBJECTIVE:

Upon completion of this task package you will be able to use hand and squaring shears to cut sheet metal. An accuracy of ± 1/64th of an inch will be the acceptable standard of performance.

LEARNING ACTIVITY:

1. View sound-slide programs M-TT-7 and M-XII-2, two super shows.
2. Read the following reference materials:
    a. *Metalwork Technology and Practice,* sections 799 to 806, pages 298 to 302.
    b. *Technical Metals*, Unit 46, pages 179 to 183.
    c. *Blueprint Reading for Machinists*, Units 20 and 21.
3. What are the following hand snips used for:
    a. Straight snips
    b. Double cutting snips
    c. Hawk-bill snips
    d. Aviation snips
    e. Circular cutting snips
    f. Heavy duty snips
4. What are hollow punches used for?
5. How do you determine the size of squaring shears?
6. For cutting several pieces the same size on a squaring shear, you would set the ______________ gage.
7. Which machine would you use to cut the bottoms for buckets?
8. You will find a treadle on what cutting machine? ______________
9. The bench shear is a large pair of scissors from ______________ ft. to ____________ ft. long.

LEARNING ACTIVITY (cont'd):

10. In reference a, you would check Table _______ on page _________ for the names of the different metal gages, what they measure, and the decimal equivalent of each gage number. Note - if you need to brush up on your decimals, take a look at Mathematics for Vocations, packages 6 and 7.

11. After your instructor has seen the above work, you may start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Hand snips
2. Squaring shears
3. Measuring tools
4. Files

1. Using the sheet metal layout from the last task package, cut out the box with squaring and hand shears.
   a. Cut your layout to its maximum dimensions with the squaring shears. CAUTION: Do not cut the tabs off your layout.
   b. Using hand snips (there is no such an animal as tin snips), cut out the remainder of the layout. NOTE - You should always cut beside the line on the scrap side. Note figure 46-6, page 180, in reference b.
   c. Using the proper file and filing methods, remove all burrs and excess metal. Besides making the box fit better, this

LEARNING PRACTICE (cont'd):

is also a safety precaution. Careful handling and filing will greatly reduce the number of cuts you will get.

d. Inspect your work carefully. Check all the measurements to make sure you are accurate to ± 1/64th of an inch.

e. Have your instructor check your work.

f. Clean up your area and return all tools to their proper places.

g. Save your layout and also the cardboard box you made in task package 2. You will need them in the next package.

Many new metalworkers are amazed at how well they can work metal. With the proper tools and careful planning you can become an excellent metalworker in a short period of time.

Metalworking talent is learned; you are not born with it!

It looks as if you're cutting out the pattern for a career as a machinist.

M-XI-4

UNIT XI: SHEET METAL

TASK PACKAGE 4: BENDING

PREREQUISITES: UNIT XI, TASK PACKAGE 3

RATIONALE:

Don't bend yourself out of shape over this package. And don't bend your workpiece out of shape, either. Just bend it into a neat box.

To change a flat piece of metal into a useful article requires that the metal go through a forming process. There are several different processes that can be used on metal, but one of the most common ones in use today is the bending of sheet metal. If you look at sheet metal that has been formed by bending, it seems like a rather simple process. However, when you have to do it, you will find it requires much more skill than the average person thinks to complete this process.

In this task package you will get a chance to bend the piece of sheet metal you have been working on. Since you have put in so much work on this piece, you will want to study and understand as much as possible about bending sheet metal. Work carefully and you will end up with a useful box.

OBJECTIVE:

Upon completion of this task package you will be able to use a hand brake to bend sheet metal forms. An accuracy of ± 1/32nd of an inch will be the standard of acceptable performance.

LEARNING ACTIVITY:

1. View slide-sound program M-XII-3, starring Bendie Metal.
2. You will get assistance for completing this task package from the following references:
   a. Metalwork Technology and Practice, Unit 40, pages 303 to 310.
   b. Technical Metals, Unit 48, pages 186 to 188.
   c. Mathematics for Vocations, package number 4. This is an excellent and simple method for calculating bend allowance.
   d. Blueprint Reading for Machinists, Units 20 and 21.
3. A bar folder only bends or folds the metal near the ________.
4. To bend or fold metal at any distance you would use a ________.
5. You may now check with your instructor and go to the Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Brake
2. Measuring tools

LEARNING PRACTICE (cont'd):

1. Using the cardboard box you made in task package 2, remove the tape and flatten the box.
2. Using the cardboard box as a guide, practice making your bends. Notice that you will have to make the bends in a certain order.
3. When you are satisfied that you can bend the box, do so, with your metal layout.
4. Check the box for accuracy and fit. You may need to do a little file work to make the fit better.
5. Show the box to your instructor.
6. Clean up the area, put away your tools and keep the box you have made for a future task package.

Making several bends on a sheet metal form can be tricky. The metalworker must study his job before he starts bending.

It seems you're bending yourself in the right direction to become a skilled machinist.

M-XI-5

UNIT XI: SHEET METAL

TASK PACKAGE 5: SEAMS

PREREQUISITES: UNIT XI, TASK PACKAGE 4

RATIONALE:

Are you ready to get in the groove with seams? Well, here's the opportunity you've been waiting for. This package deals with the single seam, double seam, and grooved seam.

The metalworker is required to do many jobs. A common one is building vessels for holding liquids or other materials. These containers are usually formed from sheet metal, and the edges are joined together with seams.

There is a wide range of seams that can be made for joining sheet metal edges. Today many of these seams will be made on the job site by a special machine that does nothing else but make one particular type of seam. There are other times, however, when the metalworker must make a seam or two for the job he's working on.

In this task package you will learn to make three different seams. These seams are made from a single hem or a double hem, the hem being the way the metal is bent. The three seams you will be making are the single seam, double seam, and the grooved seam.

Now read the Objective and continue by doing the Learning Activity and Learning Practice.

OBJECTIVE:

Upon completion of this task package you will be able to use the hand brake and seaming tools to bend and set a single hem, double hem, and grooved seam. An accuracy specified by the drawing of the part will be the performance requirement.

LEARNING ACTIVITY:

1. View sound-slide program M-XII-4, featuring Groovy Seam.
2. You will need to read the following reference materials to help you complete this task package:
   a. Metalwork Technology and Practice, Unit 40, pages 303 to 310. This is review reading, but note figure 656 on page 303.
   b. Technical Metals, Unit 47, pages 183 to 186 and Unit 50, pages 190 to 195.
   c. Blueprint Reading for Machinists, Units 22 and 23. These two units will help you brush up on your math skills.
   d. Mathematics for Vocations, package 4. Take another look at how you calculate bend allowance.
3. You will find that the same seam may be called by different names in different reference books. As an example the grooved seam in figure 656, page 303, reference a, and the flat lock seam in figure 50-1, page 190, in reference b, are the same seam.

LEARNING ACTIVITY (cont'd):

4. In this task package you will use the names from reference a.
5. Make a drawing that shows a single seam (note figure 50-4 on page 191 of reference b) 4" long and 1/2" wide. The seam will be made using two rectangular pieces of sheet metal 2" x 4". Note the use of the single hem.
6. Make a drawing that shows a double seam (note figure 50-5, page 191 of reference b) 4" long and 1/2" wide. The seam will be made using two rectangular pieces of sheet metal 2" x 4". Note the use of the double hem.
7. Make a drawing that shows a grooved seam (note figure 50-8, page 193, reference b) 4" long and 1/2" wide. The seam will be made using two rectangular pieces of sheet metal 2" x 4".
8. When you finish these drawings, show them to your instructor. You are ready to start the Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Brake
2. Layout tools
3. Measuring tools
4. Squaring shear
5. Seaming tools
6. Mallet

1. Obtain from your instructor six pieces of thin sheet metal 2" x 4".

LEARNING PRACTICE (cont'd):

2. Using your drawing of the single seam, make the single seam:
   a. Lay out the bend lines on both pieces.
   b. Bend the single hem.
   c. Bend the right angle.
   d. Join and set the seam.
   e. Check it for accuracy.
3. Using your drawing of the double seam, make the double seam:
   a. Lay out the bend lines on both pieces.
   b. Form the flange on the body or vertical piece.
   c. Form the flange on the bottom or horizontal piece.
   d. Make a single seam.
   e. Bend the single seam to form the double seam.
   f. Set the seam.
   g. Check the seam carefully for accuracy.
4. Using your drawing of the grooved seam, make the grooved seam:
   a. Lay out the bend lines on both pieces.
   b. Make a single hem in each piece.
   c. Hook the single hems together.
   d. Set the grooved seam.
   e. Carefully check the seam for accuracy.
5. Show your instructor the completed seams and your drawings.

LEARNING PRACTICE (cont'd):

6. Carefully return your tools and clean up the area. A light coat of oil on the brake will help to prevent rusting.

Even though these were fairly easy seams that you made, you should have an idea of how they could be used when making items such as boxes or parts. Your reference material has shown you many places in which seams can be used. When you get a chance, try out some of these projects.

If you work hard, success will not merely seem to be accomplished - but actually will be realized.

IM-XI-5

[illegible] SHEET METAL

[illegible]: FASTENERS

[illegible]: UNIT XI, TASK PACKAGE 5

RATIONALE:

Fasten your attention here on rivets — and rivet your [illegible] to the completion of your box.

In this task package you will complete the box you have started in previous task packages, by riveting the sides together. Many people tend to think of riveting as an [illegible] way of joining pieces of metal together. While it is true that riveting has been around for hundreds of years, new methods and technology have made riveting as up to date as tomorrow's spaceship. In fact, rivets are used on all spacecraft.

Besides riveting, you will learn something about screws and nuts in this task package and use these handy devices to help you hold your box together. There are, of course, many ways in which you can use screws and nuts besides this. A look around at home or in the classroom will show you many of the ways in which screws and nuts are used.

[illegible]

Upon completion of this task package you will be able to use machine screws and nuts, and self-tapping screws to fasten sheet metal parts. An accuracy specified on the drawing of the part will be the performance requirement.

LEARNING ACTIVITY:

1. View slide-sound program M-XII-5, featuring Rosie the Riveter.
2. Read the references that will help you complete this task package as:
   a. [illegible] Technology and Practice, Units 36 and 37, pages [illegible] to [illegible].
   b. [illegible], Unit 15, pages 97 to 102, and Unit 52, pages [illegible] to [illegible].
   c. [illegible], Units 15 to 19, pages 71 to 89.
3. Machine bolts are available with either ____________ or ____________ heads.
4. There are five types of American Standard cap screws and they are:

a. d.

b. e.

c.

LEARNING ACTIVITY (cont'd):

5. Machine screws are similar to cap screws but are generally __________________ in diameter.

6. Nuts are graded in a general way as ____________________ and __________________.

7. A flat washer ________________ the finished surface of the work, which may be marred when the bolt or nut is tightened.

8. To prevent a bolt from working loose, use a ______________ washer under the bolt head.

9. A rivet should be _____" to _____" smaller in diameter than the holes in the pieces to be riveted.

10. The rivet sizes shown on Table 52-A, page 199, in reference b are for tinner's rivets. Other rivets are sized by their diameter and length. Also included in the coding of these other rivets is the head type. As an example, the rivet may be coded as AN-426-4-5.

AN = the standard for the rivet.

426 = head shape. In this case a 100° countersink head.

4 = the diameter in 32nds of an inch.

5 = the length in 16ths of an inch.

Rivets of this type are used primarily in the aero-space industry.

11. On the cardboard layout of your box (it should still be flat), locate 2 holes in each tab for riveting. You will have a total

LEARNING ACTIVITY (cont'd):

of eight hole locations. The tabs are 3/4ths of an inch wide, so locate the hole 3/8ths of an inch in from the edge.

12. When you have completed the above work, check with your instructor and go on to the Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Layout tools
2. Measuring tools
3. Riveting hammer
4. Rivet set
5. Hand tools

1. Using the cardboard box hole locations as a guide, locate and drill holes in your metal box for rivets.
   a. Using layout tools, locate the rivet holes on the tabs.
   b. Prick and center punch the hole locations.
   c. Using Table 52-A, page 199 of reference b as a guide, select the size rivet you will use for riveting your box.
   d. Obtain from your instructor six screws and nuts. The diameter of the screws must be the same or a little smaller than the rivets you will be using.
   e. Holding the box in position securely, drill a rivet hole in the side. (Drill just one hole.)

      NOTE: If you have not drilled holes as yet, have your instructor show you how.

LEARNING PRACTICE (cont'd):

f. Put a screw in the hole you have just drilled and use a nut to secure the screw.

g. Drill all the holes and secure them with screws and nuts.

h. Deburr the two open holes and place rivets in them.

i. Set a rivet with a rivet set.

j. Upset the rivets (the head of the rivet goes on the inside of the box) with the riveting hammer.

k. Use the rivet set to form the new head.

l. For each hole remove the screw and nut, deburr the hole, install a rivet, set the rivet, upset the rivet, and head the rivet. Do this one hole at a time.

m. When you have completed the riveting, inspect the box for accuracy.

n. Have your instructor check your work.

o. Return your tools, clean up your area, and prepare to start a new unit.

You have been given a small taste of another part of the metalworker's trade. This trade has a wide range of jobs in it, and the real craftsman can do these jobs with great skill. Keep striving to be this real craftsman!

Fasten your seat belt for success, and rivet your attention to the highway that leads to it.

RESEARCH PROJECT
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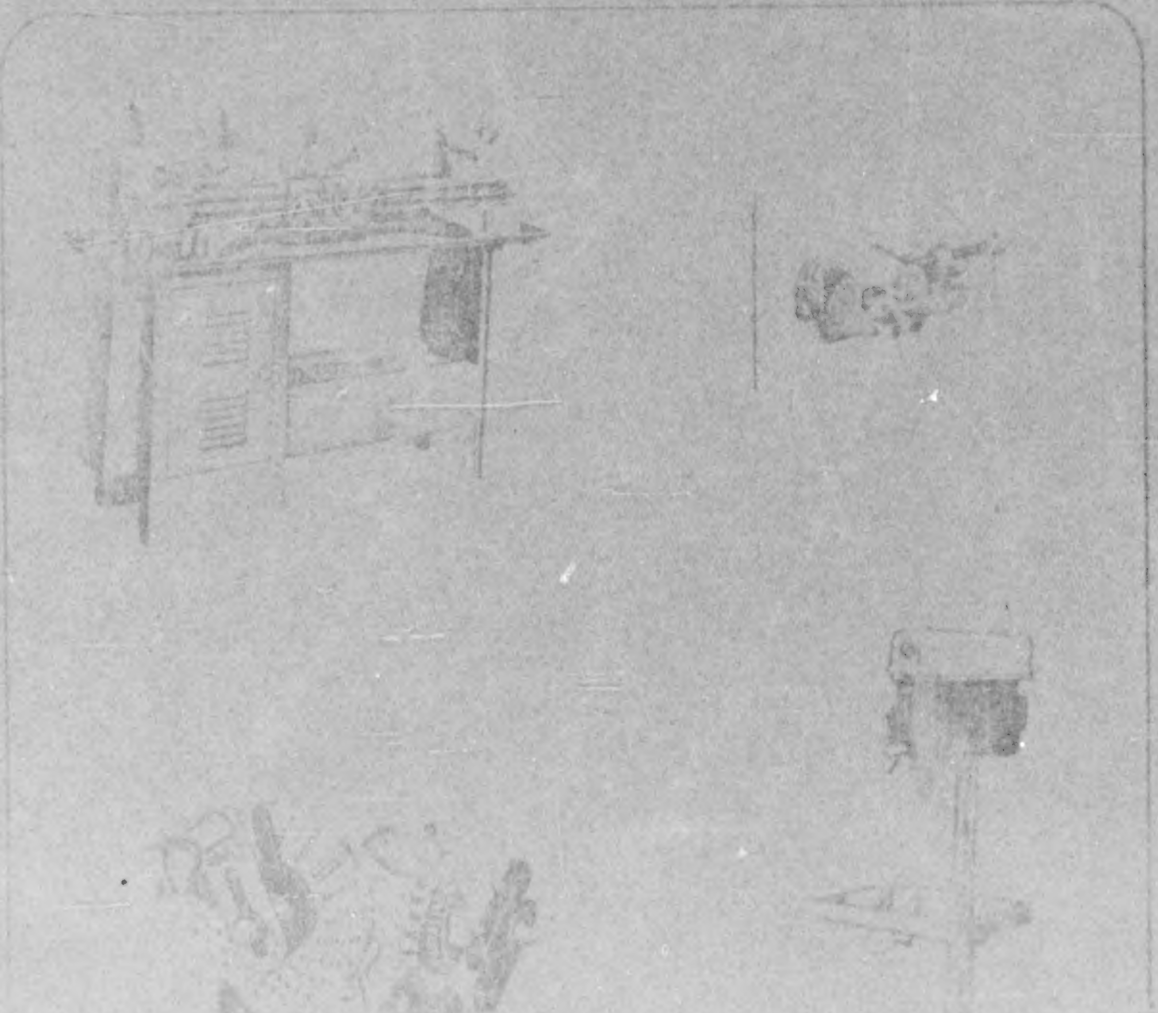


[illegible]
[illegible]

M-XII

UNIT PACKAGE XII: OXY-ACETYLENE WELDING

PREREQUISITES: UNITS I AND II

RATIONALE:

In this unit you will be introduced to oxy-acetylene welding. A welding process that is normally used around the machine shop for making repairs and sometimes rough cutting stock.

The task packages will take you step by step through a sequence of operations that you will need to know in order to learn how to weld. In each task package there will also be some items of safety that will help you to become a safe and craftsman-like welder.

You will find, as most welding students do, that after you become used to using the welding equipment that you will enjoy welding very much.

Remember, also, that welding is a very fine trade and good welders earn good pay.

OBJECTIVES:

General:

Upon completion of this unit you will be able to weld several different joints using an oxy-acetylene welding rig.

Specific:

Upon completion of the task package for this unit you will be able to:

OBJECTIVES (cont'd):

1. Do the following:
    a. use mechanical methods to clean parts to be welded.
    b. select, install, and clean torch tips according to manufacturer's specifications.

    Your performance will be evaluated in accordance with the instructor's checklist.
2. Adjust oxygen and acetylene regulators to the pressures specified by the torch manufacturer for the size of the torch tip. Your performance will be evaluated in accordance with the instructor's checklist.
3. Use a friction lighter to safely ignite and extinguish the welding torch and adjust it for carburizing, neutral, and oxidizing flame. Your performance will be evaluated in accordance with your instructor's checklist.
4. Use the forehand welding method with and without filler rod to control the weld bead in a flat position. Your performance will be evaluated in accordance with the instructor's checklist.
5. Use the forehand method of welding, without filler rod, to weld corner and edge welds. Your performance will be evaluated in accordance with the instructor's checklist.
6. Use the forehand method with filler rod for welding butt, tee, and lap joints. Your performance will be evaluated in accordance with your instructor's checklist.

LEARNING ACTIVITY:

In order to complete this unit successfully you should begin your work on Task Package 1, and then proceed to complete each task package in order until you have finished each package in this unit. In the packages you will be asked to view a sound-slide presentation, read and answer questions, and perform some practical exercises. The number and names of the task packages included in this unit are as follows:

TASK PACKAGE 1: CLEANING AND TIPS
TASK PACKAGE 2: ADJUSTMENT OF REGULATORS
TASK PACKAGE 3: IGNITING TORCH
TASK PACKAGE 4: CONTROLLING WELD BEAD
TASK PACKAGE 5: CORNER AND EDGE WELDS
TASK PACKAGE 6: BUTT, TEE, AND LAP WELDS

If you should feel confident enough to pass a comprehensive test at this time, contact your instructor. However, should you feel you are not ready to be tested, begin your work as outlined above.

M-XII-1

UNIT XII: OXY-ACETYLENE WELDING

TASK PACKAGE 1: CLEANING AND TIPS

PREREQUISITES: UNITS I AND II

RATIONALE:

You'll find some tips contained in this package - tips on cleaning and tips. And don't say we didn't tip you off.

Welding is an area of metalwork that most students seem to enjoy. At first the student may be a little nervous about handling the welding torch, but after a few hours of welding the student gains confidence in his ability and relaxes. You will probably react the same way with the welding torch.

In this task package you will learn about cleaning the metal you will be welding and also how to select, install, and clean the torch tip. These are all important parts of the welding operation and must be done with care and skill.

Besides these operations you will also learn about safety in this and the other packages in this unit. There are dangers involved with welding, but if you know what they are and how to avoid them, you will encounter no problems in your welding.

Relax and you will enjoy welding!

OBJECTIVE:

Upon completion of this task package you will be able to do the following:

a. use mechanical methods to clean parts to be welded.

b. ~~select, install, and clean torch tips according to manufacturer's~~ specifications.

Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View slide-sound program M-XIII-1, starring Tippy Toes Cleaner.
2. Reference reading for this task package is:
    a. Metalwork Technology and Practice, Unit 43, pages 327 to 331.
    b. Technical Metals, Unit 62, pages 266 to 268.
    c. Blueprint Reading for Machinists, Units 6 to 11, pages 33 to 55.
3. Clean, bright metal always welds better than dirty or oxidized (rusty) pieces, regardless of the kind of metal or the welding method used. When welding steel or wrought iron with a steel welding rod, however, perfectly bright surfaces are not absolutely necessary, as the impurities float to the top of the weld. Good welds sometimes result when the metal pieces are very dirty, but

LEARNING ACTIVITY (cont'd):

this is in spite of the dirt and it is not a result that you can expect in normal welding operations. Clean metal produces clean welds.

4. On page 266 of reference b, there are some safety precautions. In the space below write precautions 1, 2, 3, and 4:
   a.

   b.

   c.

   d.

5. Besides these safety rules, two other important safety points are made in reference b, on page 267. These points are:
   a. Acetylene is an explosive gas that becomes very unstable beyond a pressure of ________ lbs. per square inch.
   b. The acetylene valve is operated by means of a key handle which is left in __________ during the use of the cylinder.
6. Figures 1 and 2 of this task package and figure 62-5, page 267 of reference b, show some of the various types of welding tips that are used. There are many more styles and sizes than are shown in these three illustrations, but most torch tips operate in the same manner. With experience and practice you will be

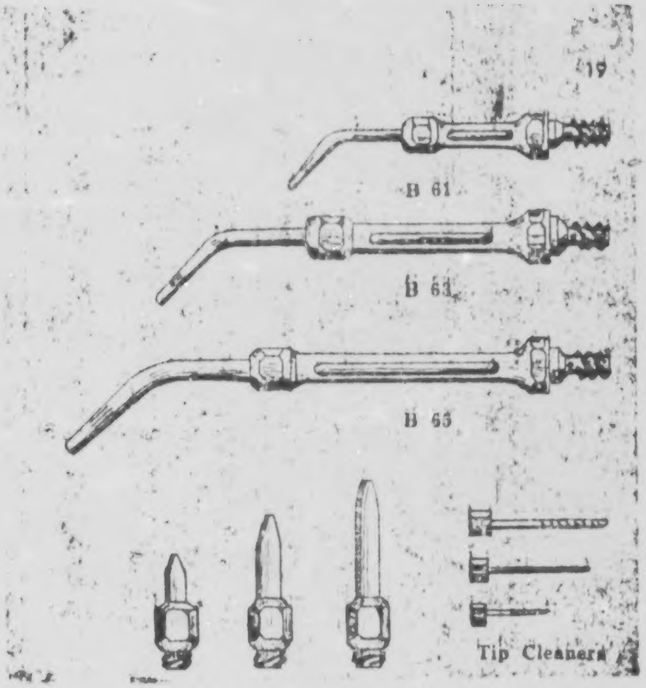


Figure 1

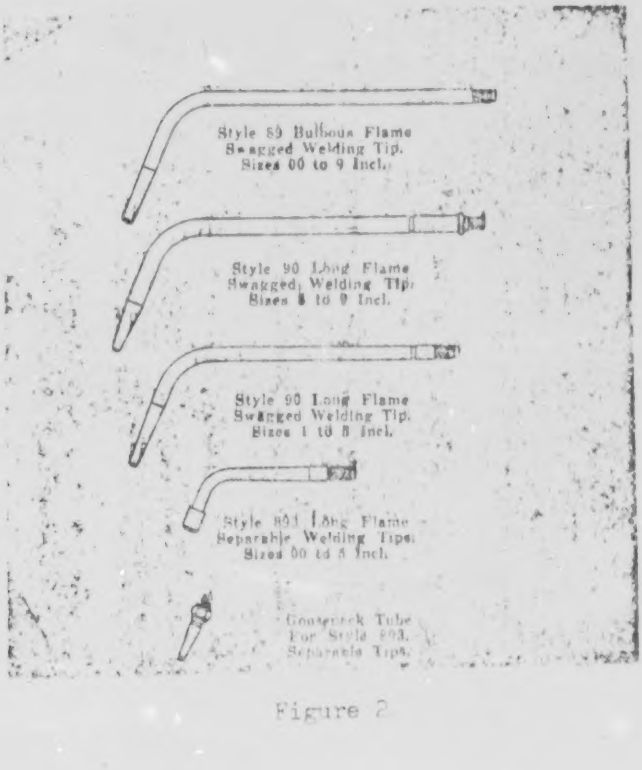


Figure 2

LEARNING ACTIVITY (cont'd):

able to select the correct tip size without too much of a problem.

7. You may now proceed to the Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Oxy-Acetylene welding rig
2. Tip cleaner
3. Clean steel wool
4. Hand grinder with wire-wheel

1. Cleaning the parts, using a wire wheel.
   a. Wear a full face shield.
   b. Always point the edge to be cleaned downward. If you raise the edge of the metal, the wire will rip it out of your hands and may cause an injury.
   c. Gauntlet gloves should be worn when using the wire wheel.
   d. Clean an area at least 1/2 inch from the edge of the metal. Thicker pieces may require a larger area cleaned.
2. Selecting, installing, and cleaning the torch tip.
   a. Use your reference material to assist you in selecting the torch tip.
   b. Install the torch tip. Do not cross thread the tip. Never force the tip; if you have trouble, investigate it or call your instructor.

LEARNING PRACTICE (cont'd):

c. Clean the torch tip using the following procedure.

NOTE - The first time that you do this cleaning operation, your instructor will turn on the oxygen and adjust the regulator for you. Watch him closely and observe what he does.

(1) Turn on the oxygen. Make sure there is no grease or oil in the vicinity.

(2) Adjust the regulator to 5 psi.

(3) Open the torch valve until you feel the oxygen lightly coming out of the torch tip. Do not use too much oxygen.

(4) Use clean steel wool and polish the torch tip until it shines brightly.

(5) Use the standard tip cleaner for cleaning the tip orifice (hole).

(6) After you have cleaned the tip, turn the oxygen off at the torch needle valve. Do not, at this time, turn off the oxygen at the regulator or at the bottle.

d. Return all your tools and equipment and clean up the area.

You will find in these task packages on welding that safety will be stressed. Oxy-acetylene welding can be a dangerous operation for the person who does not know what he is doing. You will know what to do, so it will not be dangerous for you.

UNIT XII: OXY-ACETYLENE WELDING

TASK PACKAGE 2: ADJUSTMENT OF REGULATORS

PREREQUISITES: UNIT II, TASK PACKAGE 1

RATIONALE:

You're a regular guy, no doubt. And now you've arrived at the point where you'll study regulators -- the adjustment of them, that is. So adjust yourself to this task package and continue acquiring your machinist's skills.

Oxy-acetylene welding is a common function in the machine or metal shop. Usually the shop will have a welding rig for repairing machines and equipment, and in the case of the metal shop, there may be a welding section for doing welding production work.

Basic welding can be learned quickly, but to become a real welder takes time and practice. It also takes many hours of studying to keep up with the latest improvements in welding technology. It seems as if each day brings new improvements in the welding field.

In this task package you will learn how to set the welding regulators on an oxy-acetylene welding rig. It is not a difficult task for you to do, but you must be careful when you do it.

Accidents are prevented by knowing what you are doing!

OBJECTIVE:

Upon completion of this task package you will be able to adjust oxygen and acetylene regulators to the pressures specified by the torch manufacturer for the size of the torch tip. Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View sound-slide program M-XIII-3, a regular show.
2. Reference reading for this task package is:
   - a. Metalwork Technology and Practice, sections 882 and 883, page 350.
   - b. Technical Metals, page 268, the topics Regulators, Hose, and Safety Goggles.
   - c. Blueprint Reading for Machinists, Units 11 and 12.
3. The regulators that you will be adjusting on the welding equipment in your machine shop do not have the crossbar as shown on the regulators in figures 62-8 and 62-9 of reference b. Instead, they have plastic knobs which are used in the same manner as the crossbars.
4. The standard color for the oxygen regulator is ______________, and the standard color for the acetylene regulator is _______.

LEARNING ACTIVITY (cont'd):

5. Each regulator has two gages; one gage shows the ____________ pressure and the other gage shows the ____________ pressure.

6. The color of standard oxygen hose is ____________ and the color of standard acetylene hose is ________________ .

7. The ________________ hose and regulator have left-hand threads on their fitting.

8. In the space below, write safety precautions 5, 6, 7, and 8 from page 266 of reference b.

   a.

   b.

   c.

   d.

9. You may show the above work to the instructor and start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Oxy-acetylene rig

1. The following procedure is used for adjusting the regulators for welding.

   a. Back off the crossbar or plastic knob by turning it to the left or counter-clockwise. Keep turning the crossbar or knob until it is loose and can be wiggled easily. This is a safety precaution and must always be the first thing you do when you are preparing to weld.

   b. Check the torch valves and make sure they are closed.

   c. Standing to one side of the gage (see figure 62-1, page 266, reference b), slowly turn on the oxygen at the bottle valve. This must be done slowly to prevent seat ignition, which could cause a fire. This valve must be opened completely.

   d. Still standing to one side of the gages, open the acetylene valve on the bottle no more than 1/2 turn. This is a safety precaution.

   e. Turn the crossbar or plastic knob to the right or in a clockwise direction, until you reach the desired working pressure. Usually the pressure will be the same for both gases. Note Table 62-B, page 269, of reference b.

LEARNING PRACTICE (cont'd):

    f. If you have too much working pressure, you may reduce it by backing off the crossbar or plastic knob, draining the gas out of the line by opening the torch valve, closing the torch valve, and resetting the pressure.

2. After you have set the working pressure to the desired lbs. per square inch, shut down the welding rig using the following procedure.

    a. Turn off the bottle valves. It does not matter which bottle is closed first.

    b. Drain the acetylene hose first by opening the acetylene torch needle valve. When both gages on the acetylene regulator are at zero, turn the crossbar or the plastic knob to the left until it is loose.

    c. Close the acetylene valve on the torch.

    d. Drain the oxygen hose in the same manner.

    e. Close the oxygen valve on the torch.

3. Using the above procedure, set the following working pressures on both regulators.

    a. 2

    b. 3

    c. 5

    d. 7

LEARNING PRACTICE (cont'd):

4. When you have set these pressures and feel you can do it without problems, have your instructor check your procedure.
5. Always clean your torch tip before and after you weld.
6. Clean the area and put away the tools and equipment.

You can now set the pressure on the regulators. Each step in this welding unit is important to you from the standpoint of safety and workmanship, so learn each one completely and ask questions if you have any problems.

Regulate your working pressures for the attainment of success.

M-XII-3

UNIT XII: OXY-ACETYLENE WELDING

TASK PACKAGE 3: IGNITING TORCH

PREREQUISITES: UNIT XII, TASK PACKAGE 2

RATIONALE:

Here's your opportunity to light the torch of knowledge on the subject of igniting the torch. But, you'll have to be careful when you light up, as you'll see in the rationale.

In this task package you will learn to ignite, adjust, and extinguish the welding torch. You will be using a flame that has a minimum temperature of about 5800°F. Needless to say this flame can cause severe burns if it gets close or touches you, but you can also be burned if you heat a piece of metal and then touch the metal. Many times when welding, the new welder carelessly heats the tools he has on the welding bench. He then picks up the tool and receives a serious burn on his hand. You must be cautious when you are welding.

Know what you are doing when you weld!

OBJECTIVE:

Upon completion of this task package you will be able to use a friction lighter to safely ignite and extinguish the welding torch and adjust it for carburizing, neutral, and oxidizing flame. Your performance will be evaluated in accordance with your instructor's checklist.

LEARNING ACTIVITY:

1. View sound-slide programs M-X111-4 and M-X111-4A, featuring the Old Torchlighter.
2. To aid you in completing this task package, read the following reference material:
   a. Metalwork Technology and Practice, page 331, sections 884 and 885.
   b. Technical Metals, pages 269 and 270. The topics Lighting the Torch and Adjusting the Flame, Controlling the Flame.
   c. Blueprint Reading for Machinists, Units 14, 20, and 21.
3. In reference b, on page 266, there are some safety precautions. In the space below write safety precaution numbers 9, 10, and 11:

   a.

   b.

   c.

LEARNING ACTIVITY (cont'd):

4. You will always use a ______________ lighter when lighting the welding torch.

5. Adjust the acetylene needle valve until the flame starts ______________ and ______________ away from the top end.

6. A carburizing (some books call it a carbonizing flame) flame is one that has an excess of ______________ gas.

7. An oxidizing flame is one that has an excess of __________ gas.

8. When you do not have an excess of either gas, you will have a ______________ flame.

9. To light the torch you open the ______________ needle valve ______________ turn.

10. You will never have ______________ valves open at the same time when lighting the torch.

11. After completing the above work, show it to your instructor and start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Oxy-acetylene welding rig
2. Friction lighter
3. Steel wool
4. Tip cleaner

LEARNING PRACTICE (cont'd):

1. Your instructor will demonstrate to you how to light the torch and extinguish it. Using the following procedure, prepare the welding rig:
   - a. Install a torch tip that uses 3 lbs. per sq. inch of pressure.
   - b. Adjust the regulators for 3 psi.
   - c. Clean the torch tip using oxygen.
   - d. Your instructor will demonstrate how to light the torch.
2. Lighting the torch.
   - a. Open both torch valves and close lightly. Check to see that no gas is leaking.
   - h. Open the acetylene valve about 1/2 turn.
   - c. Ignite the acetylene gas with the friction lighter.
   - d. Adjust the flame until it just touches the torch tip.
   - e. Add oxygen until you have a neutral flame.
3. Extinguish the torch using the following procedure.
   - a. Turn off the acetylene torch needle valve first.
   - b. Close the oxygen torch needle valve.
   - c. Clean the torch tip.
   - d. Drain the hoses.
4. You will demonstrate to your instructor how you can light, adjust, and extinguish the welding torch.

LEARNING PRACTICE (cont'd):

a. Adjust the torch for the following flames:

(1) Neutral

(2) Carburizing

(3) Oxidizing

5. When you have demonstrated to your instructor how you can handle the welding torch, you may want to practice some more.

6. Return your tools and equipment, clean up the area, and prepare for the next task package.

Always respect the oxy-acetylene welding rig. It can be dangerous if you think of it as a plaything.

Let the torch of knowledge light your way to success.

M-XII-4

UNIT XII: OXY-ACETYLENE WELDING

TASK PACKAGE 4: CONTROLLING WELD BEAD

PREREQUISITES: UNIT XII, TASK PACKAGE 3

RATIONALE:

Draw a bead on controlling the welding bead here. It will require a little patience, but you can do it.

To obtain skill in welding takes time and practice. You will find this out shortly, but you will also discover that you will have a fair degree of skill when you finish this unit on oxy-acetylene welding. Increasing your skill will be up to you, and this can be accomplished only by working at it.

In this task package you will learn to control the welding bead. You will first make your bead without using a welding or filler rod. When you have some degree of control of the bead with this method, you will then employ a filler rod to make a bead. There will be times when you will use both of these methods of welding, when you are working around the machine or metal shop.

OBJECTIVE:

Upon completion of this task package you will be able to use the forehand welding method with and without filler rod to control the weld bead in a flat position. Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View slide-sound program M-XIII-5, it's a real hot show.
2. To aid you in completing this task package, read the following reference materials:
   a. Metalwork Technology and Practice, sections 887 and 888, page 332.
   b. Technical Metals, page 269, the topic Welding Rod and Fluxes. Also, read the topic Torch Welding Procedures up to Butt Joint on pages 270 and 271.
   c. Blueprint Reading for Machinists, Units 22 and 23. This is a review of mathematics.
3. Write the safety precautions in reference b, page 266, numbers 12 and 13 in the spaces below:
   a.

   b.

LEARNING ACTIVITY (cont'd):

4. Mild steel welding rod has a ____________________ coating to prevent rusting.

5. Table 62-A on page 269 of reference b can aid in selecting the proper size welding rod. To weld a piece of metal that is 3/16ths of an inch thick, you would use a rod that is ______ to ______ of an inch in diameter.

6. A welding puddle that has been moved at the proper rate of speed will show an even ripple effect of ______________ width.

7. A common mistake made by many new welders is to try to move the welding puddle with the filler rod. The welding puddle is moved only by the movement of the welding torch.

8. After your instructor looks at your work you will be ready for your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Oxy-acetylene welding rig
2. Friction lighter
3. Hand and eye safety protection
4. Steel wool
5. Tip cleaners
6. Pliers

1. Obtain from your instructor a piece of flat steel about 6" x 6" and about 1/8th of an inch thick.

2. Run parallel welding beads without a filler rod using the following procedure:

LEARNING PRACTICE (cont'd):

a. Adjust the regulators.

b. Clean the welding tip.

c. Clean the metal to be welded.

d. Ignite the torch.

e. Adjust the flame.

f. Practice making and controlling the welding bead.

g. Extinguish the welding torch.

h. Clean the welding torch tip.

i. Drain the hoses and secure the welding rig.

3. Run parallel welding beads using a filler rod and the backside of the piece of metal.

a. Follow the above procedure.

b. When using a filler rod, keep it close to the heat of the torch and feed it in the front edge of the welding puddle.

c. If the weld pops, increase the amount of gases slightly.

d. Show your work to your instructor for evaluation.

4. Clean up your area and put away your tools. You are now ready for your next task package.

Welding takes time and practice. If you have burned holes in your piece of metal, don't worry about it. All new welders do this. You are doing a good job, so keep it up.

M-XII-5

UNIT XII: OXY-ACETYLENE WELDING

TASK PACKAGE 5: CORNER AND EDGE WELDS

PREREQUISITES: UNIT XII, TASK PACKAGE 4

RATIONALE:

You're coming around the corners in attaining your metals skills. Turn the corner here on corner and edge welds.

This will be a short task package, but in it you will learn about making welds without a filler rod. This type of welding is used on thin sheet metal, using the base metal itself in place of the filler rod. There are two joints that you will be welding with this method; one is a corner joint and the other is an edge or flange joint.

There is one other item you will be learning in this task package, and that is tack welding. This is a useful method of keeping parts, to be welded, together while you are welding them.

You should start to enjoy welding more in this task package. Oh, yes, welding is a well-paying job!

OBJECTIVE:

Upon completion of this task package you will be able to use the forehand method of welding, without filler rod, to weld corner and edge welds. Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View sound-slide program M-VIII-6, starring H. G. Welds.
2. Read the following reference material:
   a. Metalwork Technology and Practice, page 331, section 886.
   b. Technical Metals, page 271, the topic Corner Welds, and page 272, the topic Flange Joint.
3. When welding without a filler rod on thin sheet metal, the welder must be able to move his torch with skill. In the last task package you used a motion, either a circle or a weave, when you were welding, but on thin sheet metal it is better to use a straight motion when welding. This is somewhat harder to do, but you will get a better weld.
4. Many new welders make the mistake of judging a weld by how good the bead looks. While a good weld should have a neat appearance, the real test of a weld is the amount of penetration it has. Notice figure 62-19 on page 272 of reference b. Here you see a

LEARNING ACTIVITY (cont'd):

good example of 100% penetration. Maximum penetration is what you should strive for when welding; a good bead will come naturally as you gain experience.

5. You may now start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Oxy-acetylene welding rig
2. Friction lighter
3. Hand and eye safety protection
4. Steel wool
5. Tip cleaners
6. Pliers

1. Obtain from your instructor 4 pieces of thin sheet metal about 4" in length and 2" in width. Make a 90° lengthwise bend in two pieces of this metal. (See figure 62.19, page 272 of reference b.)
2. Weld the flanges you have just made:
    a. Clean the metal.
    b. Adjust the regulators.
    c. Clean the welding torch tip.
    d. Ignite the torch.
    e. Adjust the flame.
    f. Tack weld the pieces together.

LEARNING PRACTICE (cont'd):

   g. Weld the flange joint without filler rod.

   h. Extinguish the welding torch.

   i. Clean the welding torch tip.

3. Make a corner weld without a filler rod using the above procedure.

   a. After you finish the weld, drain the hose and secure the welding rig.

   b. Show your welding to your instructor for evaluation.

4. Clean up the area and put away your tools and equipment.

As you have been told a couple of times already, welding is a matter of time and practice. Keep at it and you will be the envy of your friends.

Success is just around the corner at the edge of work.

UNIT XII: OXY-ACETYLENE WELDING

TASK PACKAGE 6: BUTT, TEE, AND LAP WELDS

PREREQUISITES: UNIT XII, TASK PACKAGE 5

RATIONALE:

Don't butt your head against a wall. Get with this package and weld a butt, tee, and lap joint. And do your welding to a T.

You are ready to start your last task package in the oxy-acetylene welding unit. By this time you should feel comfortable with a welding torch in your hand. You should also see an improvement in your welds. It may only be a slight one, but skill is acquired very slowly.

In this task package you will be welding a butt, lap, and and tee joint. You will do this welding with the forehand method and using a filler rod. In most cases when you are welding, this is the method you will be using. Take the time to practice and learn your welding skills to the best of your ability. If you can do a good welding job, you will be called on many times to perform this skill.

Don't let yourself down; build up your skills!

OBJECTIVE:

Upon completion of this task package you will be able to use the forehand method with filler rod for welding butt, tee, and lap joint. Your performance will be evaluated in accordance with your instructor's checklist.

LEARNING ACTIVITY:

1. View slide-sound program M-XIII-7, starring B.T. Lap.
2. To complete this task package, read the following reference materials:
    a. Metalwork Technology and Practice, pages 327 to 333.
    b. Technical Metals, Unit 62, pages 266 to 274.
3. As you have noticed, the reading assignment covers the complete oxy-acetylene welding units in both books. This is done so you will get a complete overview of this welding process. There is also some new material on the different welding joints, and how they are made. Read this carefully and you will amaze yourself with how much more you understand now than you did just a few short task packages ago.
4. You are now ready to start your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Oxy-acetylene welding rig	4. Steel wool
2. Friction lighter	5. Tip cleaner
3. Hand and eye protection	6. Pliers

1. Obtain from your instructor at least six pieces of steel flat stock about 4" in length, 2" in width, and about 1/4" thick.
2. Weld at least one of each of the following joints using the forehand method and filler rod:
    a. butt joint
    b. lap joint
    c. tee joint
3. Use the following procedure:
    a. Clean the metal and prepare it for welding.
    b. Select the filler rod to be used.
    c. Select the torch tip and install it.
    d. Adjust the regulators.
    e. Clean the welding torch tip.
    f. Ignite the torch.
    g. Adjust the flame.
    h. Tack weld the joint.
    i. Weld the joint.
    j. Extinguish the welding torch.

LEARNING PRACTICE (cont'd):

k. Clean the welding tip.

l. Carefully inspect your weld. Don't touch it; it's still hot!

m. Have your instructor evaluate your welds when you have finished all three joints. Do not hand your instructor a hot piece of metal to inspect!

n. Drain the welding hose and secure the welding rig.

4. Clean up the area and return your tools and equipment to their proper places.

This completes your welding unit. Hopefully you enjoyed it and will increase your skills in this area in the future. Good luck and keep up the good work. The future is wide open for the skilled man!

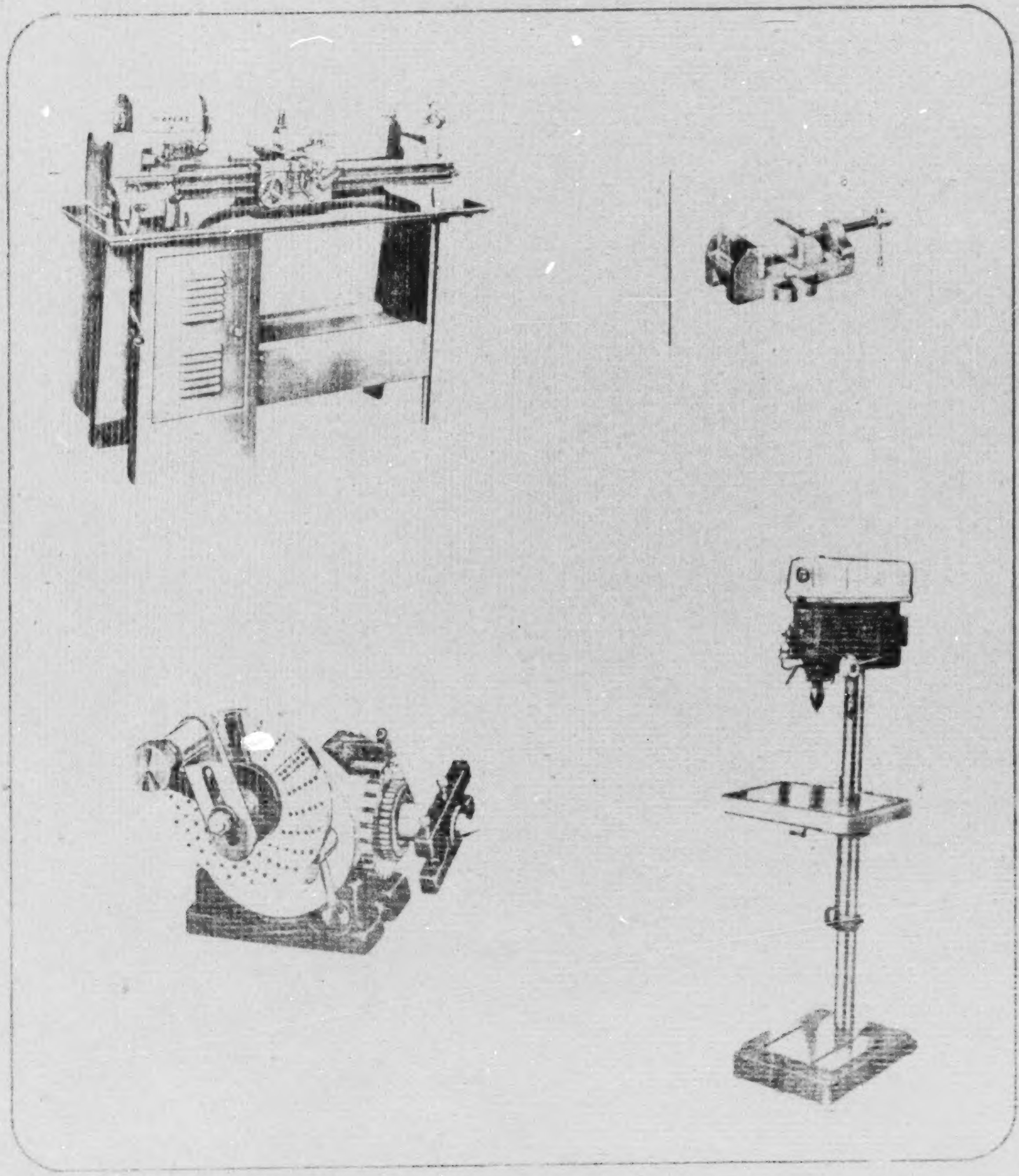
Metals could very well be your ticket to success.

RESEARCH PROJECT

SANFORD CENTRAL HIGH SCHOOL

1708 NASH STREET

SANFORD, NORTH CAROLINA 27330



CLUSTER: METALS

COURSE: MACHINE SHOP

CE003931 (N)

UNIT PACKAGE XIII: ARC WELDING

PREREQUISITES: UNITS I AND V

RATIONALE:

In this unit you will learn about and do, some basic arc welding. This is a welding process that uses a high current flow through cables to create an electric arc between the welding rod and the base metal. This arc is very hot and melts the base metal and rod, forming a puddle of molten metal, which becomes the weld when it cools.

The basics of arc welding can be learned in a short period of time, but to become a first class welder will take time and practice. Besides time and practice, you must also want to become a good welder. Welding is a complete trade in itself and one that offers many good jobs.

Most good machinists can do some welding and a basic knowledge of the subject is considered to be a part of the machinist's trade.

OBJECTIVES:

General:

Upon completion of this unit you will be able to use an electric arc welder to weld joints.

Specific:

Upon completion of the task packages for this unit, you will be able to:

OBJECTIVES (cont'd):

1. Do the following:
   a. set up the arc welder by properly connecting the welding cables to the machine and workpiece.
   b. select the proper current setting on the arc welder as determined by the type of the material, position of the weld, and the type of rod.
   c. select the appropriate arc welding rod as determined by the type and thickness of the material to be welded and the type of joint.

   Your performance will be evaluated in accordance with the instructor's checklist.

2. Do the following:
   a. prepare pieces for arc welding by cleaning and grinding them.
   b. weld butt, tee, and lap joints without deep craters or cold shoulders, and with correct penetration.

   Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

In order to complete this unit successfully you should begin your work on Task Package 1, and then, as a suggestion, proceed to complete each task package in order until you have finished each package in this unit. In the packages you will be asked to view

LEARNING ACTIVITY (cont'd):

a sound-slide presentation, read and answer questions, and perform some practical exercises. The number and names of the task packages included in this unit are as follows.

TASK PACKAGE 1: CURRENT AND ROD SELECTION

TASK PACKAGE 2: PREPARING AND WELDING JOINTS

If you should feel confident enough to pass a comprehensive test at this time, contact your instructor. However, should you feel you are not ready to be tested, begin your work as outlined above.

UNIT XIII: ARC WELDING

TASK PACKAGE 1: CURRENT AND ROD SELECTION

PREREQUISITES: UNIT I AND UNIT V

RATIONALE:

Selecting a current and rod does not mean picking a river current and a fishing rod here. Pause and focus your attention on another skill in arc welding which involves selecting different types of currents and rods. You may go fishing some other time.

The electric arc welder has been in use in one form or another for about one hundred years. The first major use for this welding process was in World War I, when it was employed to weld ships together. After this war, arc welding was somewhat slow in being refined and used for major construction. Riveting was a more popular method of joining metal together. Shortly before the outbreak of World War II, new refinements in making rods expanded the usefulness of arc welding and it became the major method of joining metals in most construction. Today all large buildings, ships and other large and small metal projects are joined by arc welding.

In this task package you will learn about arc welding. You will learn to set up the equipment and make current and welding rod selections. You will also be introduced to the necessary safety equipment that you will use. You will enjoy arc welding.

OBJECTIVE:

Upon completion of this task package you will be able to do the following:

a. set up the arc welder by properly connecting the welding cables to the machine and workpiece.

b. select the proper current setting on the arc welder as determined by the type of the material, position of the weld, and the type of rod.

c. select the appropriate arc welding rod as determined by the type and thickness of the material to be welded and the type of joint.

Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View slide-sound programs M-XIV-1 and M-XIV-2, starring Rod Current.

2. Read the following reference material as an aid in completing this task package:

   a. Metalwork Technology and Practice, pages 333 to 338 and Table 28 on page 338.

   b. Technical Metals, pages 274 to 278. Note Table 64-A on page 277.

LEARNING ACTIVITY (cont'd):

3. When doing shielded metal-arc welding, the shield is a vapor formed when the ______________ coating on the electrode is heated.
4. Alternating current is often abbreviated as ______________.
5. When arc welding, the welder adjusts the ______________.
6. If the body is not properly protected from the arc, it can be burned in much the same manner as ______________.
7. The helmet and face shield should have a number ______________ lens for electric welding.
8. You should always wear ______________, safety goggles underneath the welding helmet.
9. A long-sleeved shirt must always be worn when arc welding.
10. List the uses for these six commonly used shop tools:
    a. wire brush.
    b. chipping hammer.
    c. hammer.
    d. wedges.
    e. clamps.
    f. pliers or tongs.
11. When you have finished the above work you are ready for your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Electric arc welder

1. Examine the arc welder carefully; note the following things:
   a. the on-off switch.
   b. the low-med-high current setting holes.
   c. the male plug holes for the welding cables.
   d. the welding cables.
2. Note how you obtain the different current settings.
3. Look over the arc welding rod selection and identify the different kinds of rods.
4. Make the proper setup, current and rod selection for the following jobs:
   a. 1/8th inch steel butt weld.
   b. 1/4th inch steel lap weld.
   c. 1/2 inch steel tee weld.
5. Show your instructor how you will do these setups.
6. Explain the uses of the safety equipment you will be wearing.
7. When you have completed the above and your instructor has evaluated your performance, clean up the area and put away all tools and equipment.

You now have an idea on how to set up the arc welder, select the proper current, and also select the rod for arc welding. Besides this, you should understand the need for the safety equipment you will be wearing.

UNIT XIII: ARC WELDING

TASK PACKAGE 2: PREPARING AND WELDING JOINTS

PREREQUISITES: UNIT XIII, TASK PACKAGE 1

RATIONALE:

Here's a package you will really enjoy to the fullest. So join in on the excitement of welding joints.

In this task package you will begin to arc weld. You will start your welding by learning how to strike and maintain an arc and to run a bead. Both of these skills will be different at first, but after some practice you will be able to do them without too much trouble. When running a bead, your hand is going in two directions at the same time. It is moving in the direction of the weld and at the same time going down toward the weld. This is not a natural hand movement so it must be learned, and this learning is done by practice.

Once you have learned the above skills, the welding of the different joints will not be too hard. You will, in fact, find that you like to arc weld.

OBJECTIVE:

Upon completion of this task package you will be able to do the following:

a. prepare pieces for arc welding by cleaning and grinding them.

b. weld butt, tee, and lap joints without deep craters or cold shoulders, and with correct penetration.

Your performance will be evaluated in accordance with the instructor's checklist.

LEARNING ACTIVITY:

1. View sound-slide programs M-XIV-2 and M-XIV-3, featuring Arky Weld.

2. Reading references for this task package are:

   a. Metalwork Tech[illegible]ogy and Practice, pages 339 to 343. Note figures 729 and 730, showing the four positions for welding.

   b. Technical Metals, pages 277 to 283. You may also want to read Unit 65 about Industrial Welding Processes.

3. There are two methods of striking an arc. They are:

   a.

   b.

4. What method is easier for beginners to learn? ________________

LEARNING ACTIVITY (cont'd):

5. Too high an electrical current will cause the electrode to melt too fast and create a pool that is too ______________ and ____________________.

6. After the arc is started you should try to hold it from 1/16" to 1/8" above the weld.

7. Figure 64-18 of reference b shows several different weave bead patterns. A good welder uses these for certain types of jobs. Normally a straight motion is the best for most welding jobs. List below the four weave beads that are shown in figure 64-18.

   a.

   b.

   c.

   d.

8. Figure 64-14 of reference b shows the characteristics of various welding bead conditions. Use this as your guide when you are welding.

9. Have your instructor approve your work and go on to your Learning Practice.

LEARNING PRACTICE:

Tools and Equipment

1. Arc welder
2. Safety equipment

LEARNING PRACTICE (cont'd):

3. Wire brush
4. Chipping hammer
5. Pliers or tongs

1. Obtain from your instructor a piece of flat stock about 6" x 6" and over 1/4" thick.
2. Using the following procedure, weld parallel practice beads on the piece of stock. Note that this is practice work, and the purpose of doing it is to familiarize yourself with starting and maintaining an arc and also controlling your bead.
   a. Clean the workpiece.
   b. Set up the arc welder.
   c. Select the current setting.
   d. Select the welding rod.
   e. Attach the ground cable.
   f. Put on your safety equipment.
   g. Weld a bead.
   h. Chip and wire brush the bead. Make sure you wear goggles when doing this.
   i. Examine the bead and make adjustments if necessary.

NOTE - You always chip and wire brush after you run a bead. Do not weld over the slag left by a weld as this will cause pockets in your weld.

LEARNING PRACTICE (cont'd):

j. Run another bead parallel to the first one.

k. Keep running beads until you feel you can maintain and control the arc and bead; then go on to the next steps.

3. Obtain from your instructor six pieces of flat stock about 2" x 6" x 1/4" thick and weld a butt, tee, and lap joint using the following procedure.

    a. Clean the pieces.
    b. Grind grooves if necessary.
    c. Set up the arc welder.
    d. Select the current setting.
    e. Select the welding rod.
    f. Attach the ground cable.
    g. Clamp your work if necessary.
    h. Put on your safety equipment.
    i. Tack the pieces.
    j. Chip and wire brush the tacks.
    k. Weld the joint.
    l. Chip and wire brush the weld.
    m. Inspect the bead.
    n. Have your instructor evaluate your work.
    o. Clean up the area and return all tools and equipment to their proper places.

LEARNING PRACTICE (cont'd):

When done properly, arc welding is a fast and strong method of joining metals together. You will find welding to be one of the most useful skills you have learned.

Weld your best abilities into beads of success.